A PROSPECTIVE STUDY OF

"FUNCTIONAL AND RADIOLOGICAL OUTCOME OF NECK OF FEMUR FRACTURE TREATED BY BIPLANE DOUBLE SUPPORTED SCREW FIXATION METHOD"

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CERTIFICATE

This is to certify that this dissertation Entitled "**Functional and Radiological Outcome of Neck of Femur Fracture Treated by Biplane Double Supported Screw Fixation Method** " is a record of bonafide research work done by **Dr. R.KARTHIK**, Postgraduate student under my guidance and supervision in fulfilment of regulations of the TheTamilnadu Dr. M. G. R. Medical University for the award of M. S. Degree Branch II (Orthopaedic Surgery) during the academic period from May 2015 - March 2018, in the Department of Orthopaedics, Government Royapettah Hospital & Government Kilpauk Medical College, Kilpauk, Chennai- 600010.

Prof Dr. R.Balachandran,
M. S. Ortho., D. Ortho.
Professor of Orthopaedics,
Department of Orthopaedics,
Govt. Royapettah Hospital,
(Govt. Kilpauk Medical College),
Chennai-600 010

Prof.Dr.S.Senthil kumar
M.S. Ortho., D.Ortho
Professor & HOD
Department of orthopaedics
Govt. Royapettah Hospital
Govt. Kilpauk Medical College
Chennai-600 010

Prof. Dr. Vasanthamani, MD, DGO, MNAMS, DCPSY, MBA
Dean
Govt. Kilpauk Medical College
Chennai – 600 010

DECLARATION

I, **Dr. R.KARTHIK**, solemnly declare that this dissertation, **"Functional and radiological outcome of neck of femur fracture treated by biplane double supported screw fixation method."** is a bonafide work done by me in the Department of Orthopaedics, Govt. Royapettah Hospital, Kilpauk Medical College, Chennai under the guidance of **Prof. Dr. R.BALACHANDRAN,** M.S.Ortho., D.Ortho., Professor of Orthopaedics, Department of Orthopaedics, Govt. Royapettah Hospital, Govt. Kilpauk Medical College, Chennai- 600010.

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Place: Chennai Signature

Date: **(Dr.R.KARTHIK)**

Signature of the Guide

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CONTENTS

INTRODUCTION

The neck of femur fracture is one of the common fractures in elderly. It has been always a challenge to the orthopaedic surgeons to manage these fractures.

The prevalence of neck of femur fractures has increasing with increased incidence of osteoporosis, poor vision in elderly, poor neuro muscular coordination, life style changes, sedentary habits, improvement in life expectancy. The incidence is expected to be double in next twenty years, triple by 2050. The burden of neck of femur fractures and its sequelae continued to be on the rise. The treatment goal for this fractures is restoring of functions without morbidity, still controversy exists in management of neck of femur fractures in elderly. Treatment complications originate from insufficient reduction, unstable fixation, and poor–quality osteoporotic bone.

Cannulated screws are often used for osteosynthesis of femoral neck fractures; however, this osteosynthesis is associated with poor results in 21–46% of the clinical cases. Screw configuration has been investigated in several biomechanical studies. Currently, there is rather a divergence of views and concepts. The majority of authors recommend placement of the distal screw so that it is supported by the distal femoral neck cortex, which is traditionally called the “calcar”, although this is not the true anatomic calcar. Central screw placement on the lateral view is advised in some papers, while other authors suggest peripheral placement. Secured posterior cortical screw support is also recommended. It is widely accepted that the screws should be placed parallel to each other .However, the dictum of parallel placement has not been proven and some authors prefer divergent placement on the lateral view . The inverted triangle configuration is usually favoured because it provides higher stability, and screw insertion at higher angles relative to the diaphyseal axis seems to achieve better fixation strength.

The current conventional method for femoral neck fracture fixation uses three parallel cannulated screws, but this does not always provide appropriate fixation strength. This is especially true if osteoporosis is present, and poor results might subsequently develop. The initial interfragmentary compression of these constructs is frequently insufficient and therefore unable to ensure stability in osteoporotic bone. Moreover, the constructs could be occasionally unstable with regard to varus stresses, anteroposterior bending and torsion because of the screws inserted pretty close to each other with entry points localized in the rather thin section of the cortex near to the greater trochanter, lacking appropriate lateral cortical support

When cannulated screws are used to fix a femoral neck fracture with osteoporosis, intraoperative interfragmentary compression alone may not ensure adequate stability during the healing process because it could soon be lost on fracture impaction. Construct stability can be considerably increased if cannulated screws with better cortical support in the distal fragment are used, acting more effectively as console beams with overhanging ends.

Filipov's novel method for biplane double–supported screw fixation (BDSF) can increase fixation stability, demonstrates a high degree of reproducibility during its standardised surgical procedure, and has been clinically applied since 2007. The innovative concept of biplane screw positioning makes it feasible to place three cannulated screws at steeper angles to the diaphyseal axis in order to improve their beam function and cortical support.

The three screws are laid in two vertical oblique planes that medially diverge toward the femoral head on lateral view. The distal screw is placed in the dorsal oblique plane with additional support by the posterior femoral neck cortex. The middle and proximal screws are oriented in the ventral oblique plane.

The entry points of the screws, which are placed with steeper angles relative to the diaphyseal axis, are located much more distally within the thicker cortex of the proximal diaphysis. BDSF uses two calcar–buttressed screws: the distal and the middle ones with different coronal inclinations of 150–165º and 130–140º, respectively. Each of these screws is placed with the following two supporting points (pivots) in the distal fragment: the medial supporting point on the distal femoral neck cortex, and the lateral supporting point at the screw–

entry point into the lateral diaphyseal cortex. The distal screw has an additional third supporting point on the posterior femoral neck cortex.

The two calcar–buttressed screws are oriented in different coronal inclinations in order to maintain constant stability during various physical activities. Their medial supporting points are located 10–20 mm apart, thereby distributing the axial load over a larger cortical area. The enhanced cortical support and increased angle improve the beam function of the calcar–buttressed screws when standing, whereas the proximal screw stabilizes the upper neck under tensile stress. In addition, the distal screw, with its three supporting points, provides improved beam resistance to AP bending forces (e.g., rising from a chair), while the two anterior screws hold the side under ten

AIM

- Our aim is to manage the femoral neck fractures by biplane double supported screw fixation (BDSF) and follow them prospectively.
- Functional and radiological outcomes were studied and reviewed
- Functional outcomes in our patients were studied using Harris hip score

REVIEW OF LITERATURE

Ambroise Pare, a French surgeon and anatomist was the first person to described fracture of proximal femur in 1564.

Emil Theodor Kocher suggested two mechanisms of injury in femoral neck fractures. The first was a fall producing a direct blow over the greater trochanter. This mechanism was confirmed by Linten in 1955. The second mechanism is external rotation of the extremity which was confirmed by Protzman et al in 1976.

Sir Jacob Astley Cooper in 1882 was the first to distinguished between intra- and extra-capsular fractures.

In 1985, Roentgen invented the X-rays and it paved a new way for conservative management of femoral neck fractures.

The concept of traction was introduced in the mid-19th century with the goal of minimizing limb shortening and deformity. Multiple schemes for traction were devised, but high rates of non-union encouraged efforts to achieve reduction and apply forceful impaction as part of the closed treatment algorithm for femoral neck fractures.

Whitman in 1902 initially applied a hip spica in children for immobilization after closed reduction by manipulation.

In 1933, Lead better developed another technique of closed reduction maintained in a hip spica with higher rate of union. Speed published the classic article "The unsolved fracture" in 1935 in which he described another technique of closed reduction[17]. Union rates for closed reduction and spica casting from the 1930s was recorded at only 23%. Eric Lexer of Germany in 1908 used autogenous bone graft to facilitate union in case of nonunions.

Attempts at internal fixation date back to isolated cases as early as 1850. Senn made a plea for internal fixation of femoral neck fractures when reporting his results from canine trials in 1877, but after his argument was largely rejected by the surgical community, he reverted to advocating closed reduction and impaction. In 1916 Hey Groves initiated use of his quadra-flanged nail the results of which were published in 1926. Despite the publicity this received, the most widely used internal fixation through the early part of the 20th century were "bone pegs"—crude intra- medullary devices of ivory or beef bone used to keep the fracture ends roughly aligned.

Smith-Petersen, et al. in 1931 reported a series of open nailings with his tri-flanged nail, a simple internal fixation device designed to achieve maximum purchase of both fragments but allow some impaction along the fracture line. In 1932, Johansson introduced a canulated nail which assisted closed reduction of fracture and then fixing the fracture. It was slightly modified by Westcott in 1934. Thronston devised a side plate to the triflanged nail in 1937 which further paved way for Jewett nail-plate device in 1941. Smith-Petersen's idea evolved further with the introduction of the cannulated Smith-Peterson nail and the technique for low angle insertion, designed to capture low on the calcar and centrally in the femoral head[22].

The same three-point fixation concept introduced at this time is still relevant in the treatment of femoral neck fractures today. Multiple pin constructs, which permitted the open or percutaneous fixation of femoral neck fractures, were introduced by Knowles and Moore and were the precursor of today's cannulated screws.

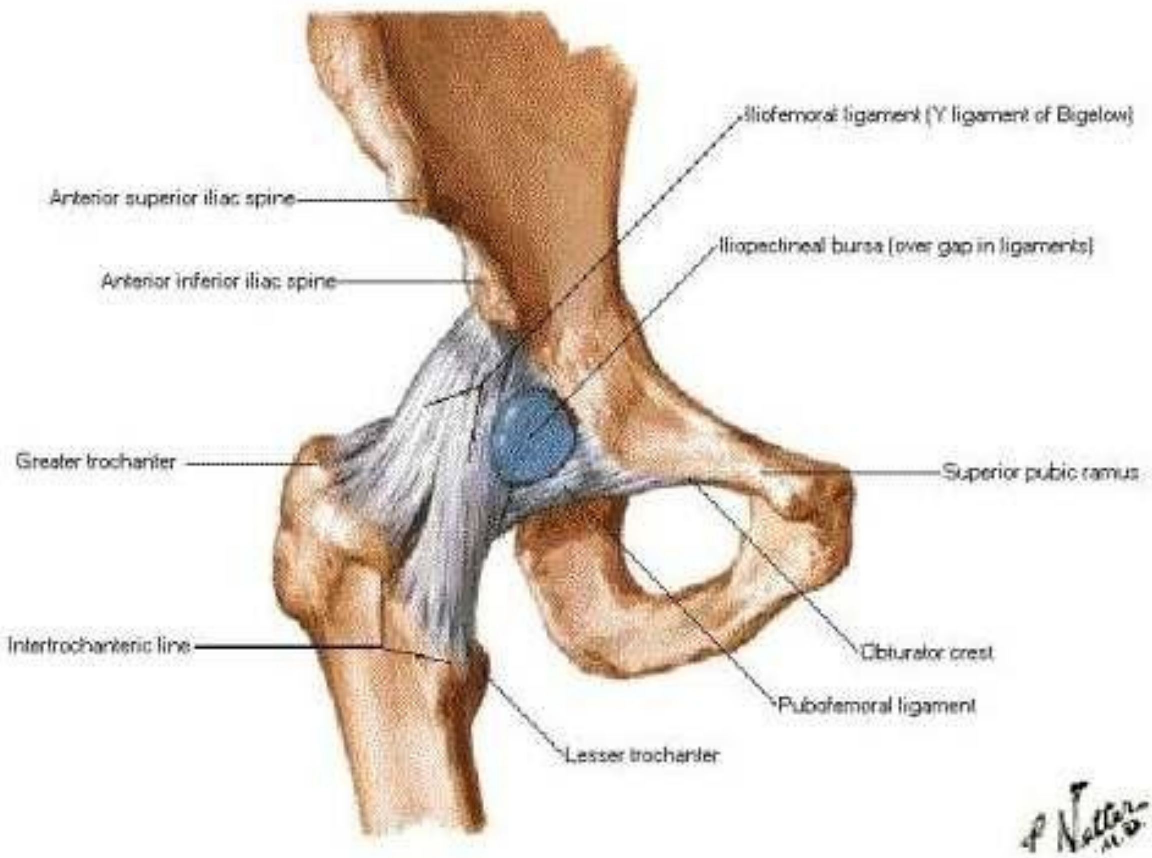
Harmon in 1944 added a side plate for accommodating these pins. It was later modified by Deyerle in 1958 which had a template for multiple pin insertion and sliding. The use of the dynamic hip screw in the treatment of intra-capsular fractures has also been reported.

ANATOMY OF THE HIP JOINT

The hip joint is an enarthrodial or ball-and-socket joint, formed by the reception of the head of the femur into the cup-shaped cavity of the acetabulum. The ball-and-socket type of architecture provides it a high degree of the stability as well as a good range of movement. The articular cartilage on the head of the femur, thicker at the center than at the circumference, covers the entire surface with the exception of the fovea, to which the ligamentum teres is attached. The articular cartilage on the acetabulum forms an incomplete marginal ring, the lunate surface. Weight bearing occurs in the upper part of the acetabulum where the cartilagenous strip is widest. Within the lunate surface there is a circular depression devoid of cartilage, occupied in the fresh state by a mass of fat and covered by synovial membrane.

The articular capsule is strong and dense. Above, it is attached to the margin of the acetabulum 5 to 6 mm beyond the glenoidal labrum posteriorly and anteriorly it is attached to the outer margin of the labrum. It surrounds the neck of the femur, and is attached, in front, to the intertrochanteric line and the base of the neck anteriorly and posteriorly to the neck, about 1.25 cm above the intertrochanteric crest. From its femoral attachment some of the fibers are reflected upward along the neck as longitudinal bands, termed retinacula.

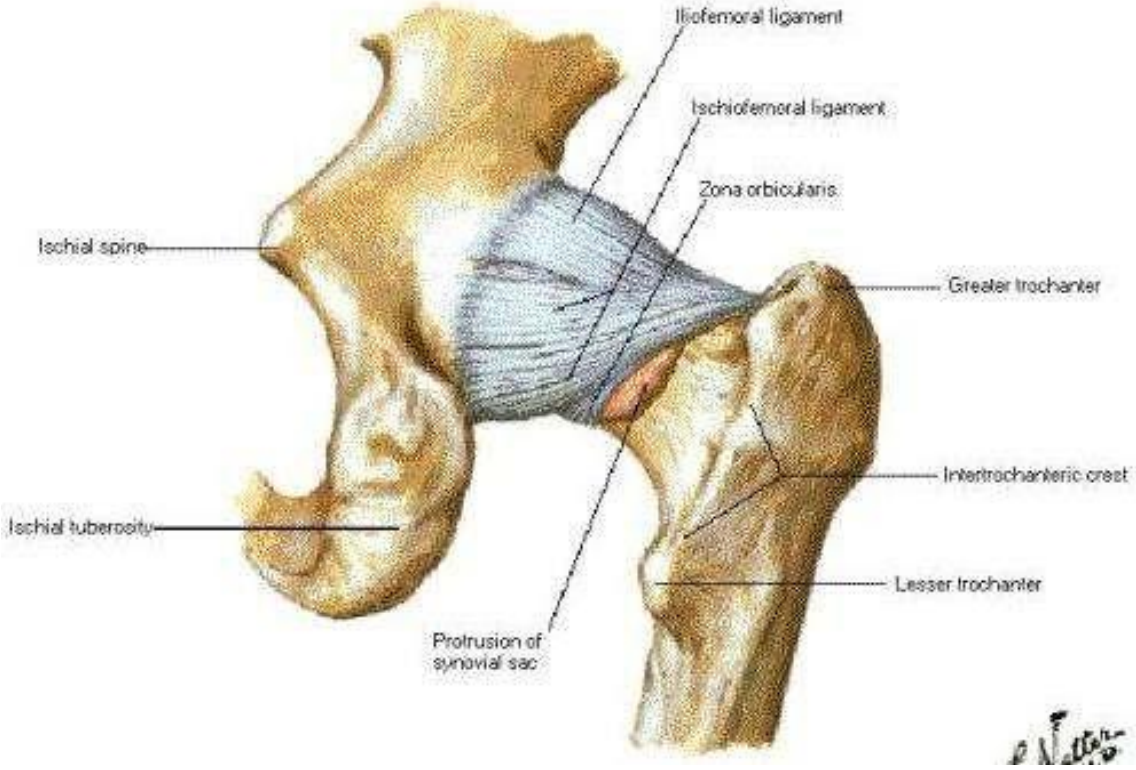
The capsule is much thicker at the superior and anterior part of the joint where the greatest amount of resistance is required. However, the capsule is thin and loose inferiorly and posteriorly. The thickened outer longitudinal fibres of the capsule form three strong ligaments around the hip joint.



HIP JOINT – ANTERIOR VIEW

The ilio-femoral ligament/ Y-shaped ligament of Bigelow is the strongest ligament in the body and lies in front of the joint. It is intimately connected with the capsule, and serves to strengthen it in this situation. It is attached, above, to the lower part of the anterior inferior iliac spine; below, it divides into two bands, one of which passes downward and is fixed to the lower part of the intertrochanteric line; the other is directed downward and lateralward and is attached to the upper part of the same line. In some cases there is no division, and the ligament spreads out into a flat triangular band which is attached to the whole length of the intertrochanteric line.

The pubo-femoral ligament is attached, above, to the obturator crest and the superior ramus of the pubis. Below, it blends with the capsule and with the deep surface of the vertical band of the ilio-femoral ligament. The Ischio-femoral ligament/ligament of Bertin consists of a triangular band of strong fibers which spring from the ischium below and behind the acetabulum and blend with the circular fibers of the capsule.



HIP JOINT – POSTERIOR VIEW

The Ligamentum Teres Femoris is a triangular, somewhat flattened band implanted by its apex into the antero-superior part of the fovea on the head of femur. Its base is attached by two bands, one into either side of the acetabular notch, and between these bony attachments it blends with the transverse ligament. It is ensheathed by the synovial membrane varies greatly in strength in different individuals. The ligament is made tense when the hip is semiflexed, adducted and externally rotated. It is relaxed when the limb is abducted.

The Glenoidal Labrum is a fibrocartilaginous rim attached to the margin of the acetabulum, the cavity of which it deepens. It also protects the edge of the bone, and fills up the inequalities of its surface. It bridges over the notch as the transverse ligament, and thus forms a complete circle, which closely surrounds the head of the femur and assists in holding it in its place. It is triangular on section, its base being attached to the margin of the acetabulum, while its opposite edge is free and sharp. Its two surfaces are invested by synovial membrane, the external one being in contact with the capsule, the internal one being inclined inward so as to narrow the acetabulum, and embrace the cartilaginous surface of the head of the femur.

The Transverse Acetabular Ligament is in reality a portion of the glenoidal labrum, though differing from it in having no cartilage cells among its fibers. It consists of strong, flattened fibers, which cross the acetabular notch, and convert it into a foramen through which the nutrient vessels enter the joint.

MUSCLES AROUND THE HIP

A. MUSCLES IN FRONT OF THE THIGH

1. Psoas major
2. Ilaicus
3. Tensor fascia latae
4. Sartorius
5. Quadriceps femoris

B. Muscles of the gluteal region

1. Gluteus maximus

2. Gluteus medius
3. Gludeus minimus
4. Obturator internus
5. Superior and inferior gemelli
6. Quadratus femoris

C. Muscles posterior to the hip :

1. Semi tendinosus
2. Semimembranosus
3. Biceps femoris

D. Medial muscles of hip :

1. Pectineus
2. Adductor longus
3. Adductor brevis
4. Adductor magnus

MOVEMENTS OF THE HIP

The hip joint, being a ball and socket type of joint allows movements in a multidirectional pattern. Grossly the movements are as follows:

Flexion – Anteriorly, Extension – Posteriorly, Abduction & adduction – Laterally Rotations and combination of the above - Circumduction.

When the thigh is flexed upon the trunk, the head of femur rotates about the transverse axis that passes through both acetabulae, the muscles that bring about this motion are iliopsoas - supported by Rectus femoris, sartorius and pectineus. Flexion gets arrested when the thigh is on the trunk and by the hamstrings when knee is in extension. Normal flexion is about 120° - 130^{0}.

EXTENSION

This is the opposite of flexion, carried out by the Gluteus maximus. The motion is limited by tension of ileo-femoral ligament.

Normal range is 5° - 20°.[61]

ADDUCTION

Adduction of the thigh produces similar movements in the femoral shaft and neck. The femoral head rotates in the acetabulum over an anteroposterior axis. Movements are brought about by- Pectineus, adductors, gracilis. It is limited when the thigh rests upon the opposite one or if the latter is kept abducted, the tension in the gluteus medius and minimus limits the adduction. Normal range $25^{0} - 35^{0}$.

ABDUCTION

This is the opposite of abduction and is brought about by gluteus medius and minimus assists by piriformis. It is limited by tension on the adductors and pubo- femoral ligament. Normal range 40° - 45°.

EXTERNAL ROTATION

This is carried out by flexing the hip and knee to 90 and rotating the foot towards the opposite side. Gluteus maximus is the major lateral rotator. The gluteus medius, minimus, piriformis, obturator internus, gamelli and quadratus femoris serve as stabilisers of the hip. Normal range is about 40-45° as measured in both extension and flexion of the hip.

INTERNAL ROTATION

With the hip and knee flexed to 90^0, the leg being rotated away from the midline of the body produces medial rotation at the hip and is brought by anterior fibres of gluteus medius and minimus. Normal range is $40°-45^0$ in flexion and 30^0-35^0 in extension.

BLOOD SUPPLY OF HEAD AND NECK OF THE FEMUR

Avascular necrosis of femoral head is one of the most serious complication following femoral neck fractures, which have all the problems associated with healing of intracapsular fractures elsewhere in the body. Hip joint capsule is strong fibrous structure which encloses femoral head and most of its neck. That portion of neck which is intracapsular has no cambium layer to participate in peripheral callus formation. Thus femoral neck area is dependent on endosteal union alone.

Arterial supply of proximal end of femur has been studied extensively. Crock described arteries of proximal end of femur into 3 groups and provided a definitive anatomical nomenclature to these vessels thus avoiding ambiguity.

1. The extra-capsular arterial ring located at the base of femoral neck.
2. The ascending cervical branches of extra-capsular arterial ring on the surface of the femoral neck.
3. The arteries of the round ligament.

The extra-capsular arterial ring is formed posteriorly by a large branch of medial circumflex femoral artery and anteriorly by branches of lateral circumflex femoral artery with the superior and inferior gluteal arteries having minor contributions to this ring.

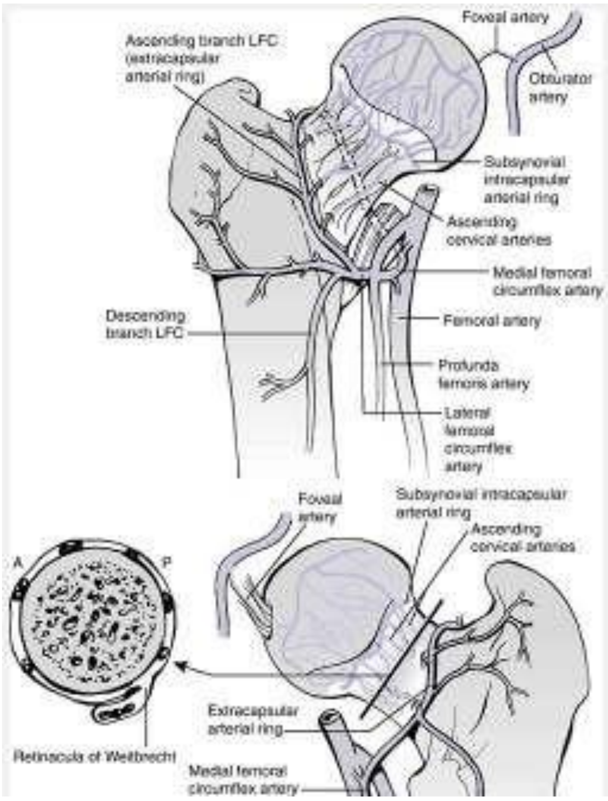
The ascending cervical branches arise from the extra-capsular arterial ring. Anteriorly they penetrate the hip joint capsule at the intertrochanteric line and posteriorly they pass beneath orbicular fibres of the capsule. The ascending cervical branches pass upward under the synovial reflections and fibrous prolongations of capsule towards the articular cartilage that demarcates femoral head from its neck. These arteries are called retinacular arteries described initially by Weitbrecht. This close proximity of retinacular arteries puts them at risk of injury in any fracture neck of femur. As the ascending cervical arteries traverse superficial surface of the neck of the femur they send small branches into the metaphysis of femoral neck.

As the ascending cervical arteries traverse the superficial surface of the femoral neck, they send many small branches into the metaphysis of the femoral neck. Additional blood supply to the metaphysis arises from the extracapsular arterial ring and may include anastomoses with intramedullary branches of the superior nutrient artery system, branches of the ascending cervical arteries, and the subsynovial intra- articular ring. In the adult, there is communication through the epiphyseal scar between the metaphyseal and epiphyseal vessels when the femoral neck is intact.

This excellent vascular supply to the metaphysis explains the absence of avascular changes in the femoral neck as opposed to the head. The ascending cervical arteries can be divided into four groups based on their relation to the neck of femur - anterior, posterior, medial and lateral. Of these the lateral providing most of the supply to femoral head and neck. At the margin of articular cartilage on the surface of the neck of femur, these vessels form a second ring – the subsynovial intra-articular ring described by Chung, which can be complete or incomplete, the complete rings being more common in male specimens. At the subsynovial intra - articular ring - epiphyseal arterial branches arise that enter head of the femur. Disruption of this arterial ring in high intra-articular fractures, leads to aseptic necrosis. Once the arteries from subsynovial arterial ring penetrate femoral head they are termed as epiphyseal arteries. Claffey demonstrated that in all femoral neck fractures that communicated with the point of entry of the lateral epiphyseal vessels, aseptic necrosis occurred.

The artery of ligament teres is a branch of obturator or the medial circumflex femoral artery. This arterial supply is often inadequate to provide nourishment to the femoral head. Howe, et al found that although the vessels of the ligamentum teres did supply vascularity to the femoral head, they were often inadequate to assume the major nourishment of the femoral head after a displaced femoral neck fracture.

Claffey also reported that simple patency of the vessels of the ligamentum teres did not make them capable of keeping the femoral head alive if all other sources of blood supply were interrupted.



BLOOD SUPPLY TO THE HEAD AND NECK OF FEMUR

CLINICAL SIGNIFICANCE OF VASCULAR ANATOMY

Femoral head circulation arises, therefore, from three sources: (a) intra- osseous cervical vessels that cross the marrow spaces from below; (b) the artery of the ligamentum teres (medial epiphyseal vessels); and (c) the retinacular vessels, branches of the extracapsular arterial ring, which run along the femoral neck beneath the synovium.

When a femoral neck fracture occurs, the intraosseous cervical vessels are disrupted; femoral head nutrition is then dependent on remaining retinacular vessels and those functioning vessels in the ligamentum teres. The amount of the femoral head supplied by the medial epiphyseal vessels varies from a small area just beneath the fovea to the entire head. Sevitt and Thompson reported that the anastomoses between the subfoveal vessels and other vessels in the femoral head may be insufficient to support viability. Therefore, every attempt should be made to protect the remaining vascular supply to the femoral head after fracture.

BIOMECHANICS OF HIP JOINT:

The hip joint is a ball and socket joint , it provides the multiaxial movement in the joint. The structures responsible for stability are

1. Bony structures
2. Ligaments around hip

3. Muscles attaching around hip joint,

But ligaments and muscles less relying, bone is the major stabilizer. The bony structures responsible for the stability in walking, change of postures from sitting to standing, from standing to sitting.

These function will be disturbed, when there is a fracture in the neck of femur & disturbances of supporting structures. The treatment is aimed at providing support, restoring the function, anatomical realignment.

Basic structures:

Bony structures plays a vital role in supporting the frame work. Cortical and Cancellous bones have their respective distinct mechanical properties. Cortical bone is solid and rigid structure, its anisotrophic feature makes the analysis difficult.

In, 1807, von weyer (anatomist), culman (an engineer) made comparison and developed the stress trajectorial bone theory by comparing the trabecular patterns of Cancellous bone in the neck of femur with the fairbrain cane.

The proportion of cortical and Cancellous bone in the neck of femur and trochanter is different, in neck 95 percent is cortical, whereas reverse in trochanter.

Paul calculated the direction and magnitude of force across femur head in walking and gait. Under normal circumstances, maximum compression on the medial aspect of the neck than lateral aspect of neck. There is no tension force in the neck at rest. On loading and in unphysiological conditions tension produced in the lateral and superior aspect of femur neck. So, compression is the major loading configuration of proximal femur with tension only in abnormal conditions. The multi axial movement in the low friction joint makes the tension in neck less negligible.

Articular Cartilage:

Articular cartilage is very important in

1. Load transmission
2. Absorption of energy
3. Joint lubrication

The contact and weight bearing area is demonstrated by greenwald. Bullogh et al., described the importance between articular surfaces. The friction coefficient between articukar surfaces in the range of 0.005 - 0.01. To achieve this advantageous level, which reduces the wear to very minimum, many theorie shave been put forward.

Muscles and ligaments :

The arrangements of muscles and ligaments around hip provide the support, movements, prevent abnormal movements, proprioception, absorption of energy after fall.

Factors Acting on Hip Joint :

The factors acting on hip joint are

1. Body weight
2. muscle forces around hip

The force exerted by the movements across joint is described by rydell, in terms of magnification factor to body weight.

Standing on one leg = 2.5 * body weight

Standing with 2 legs : force = ½ body weight to each joint

Running : force = 5 times * body weight

Mechanism of injury :

Fracture neck of femur is common in elderly women due to osteoporosis. It is uncommon in young patients and few races like black people. Most of the fractures is due to trivial fall and minor trauma. Ethil theodor kocher suggested 2 mechanism of injury in neck of femur fractures.

1. Direct blow over greater trochanter which was confirmed by linten in 1955.
2. External rotation of the extremity which was confirmed by protzman in 1978. In this mechanism while there is external rotation, the head is fixed firmly by anterior capsule & ileofemoral ligament. The posterior cortex of the neck impinges on the acetabulum and buckling happens.

   The third mechanism is a cyclical loading which produces micro and macro fractures.

In osteoporotic bone forces within physiological limits will produce fractures.

Mechanism of bone failure:

In the hip joint, overloading occurs due to number of independent but often inter related factors. The important factors are

1. Influence of fall
2. Impairment of energy absorbing mechanism
3. 0steoporosis

Influence of fall :

In standing position, body possess considerable amount of potential energy while falling potential energy converted to kinetic energy which should be absorbed by body structures, if not fractures occurs. In an human, average amount of energy absorbed by the body on fall would be approximately 4000 kg/cm, but in the proximal femur its only about 500 kg/cm.

Impairment of energy absorbing mechanism:

The dissipation of energy is done by active contraction of muscle. The dissipation requires reacting time. In high velocity injury, no sufficient period for the muscles to contract to absorb energy to avoid overloading. In the elderly patient, there will be slower neuromuscular coordination, thus there will be impairment of energy absorbing mechanism

Bone weakness:

In osteoporosis, the bone strength reduces to approximately 3/4th of the normal healthy bone with low energy absorbing capacity leading to failure. Aitkin et al in 1984, demonstrated the presence of osteoporosis (mild to severe) in 84 percent of patients with neck of femur fractures. Dorne and lander described a group of patient who sustained neck of femur fracture spontaneous without apparent trauma. They used the term insufficiency fractures to describe the neck of femur fractures in elderly with osteoporosis. Griffin et al showed fatigue fracture can occur in elderly if neck of femur on cyclical loading within physiological limits. Freeman et al demonstrated subcapital fractures in osteoporosis due to fatigue, preceded by isolated trabecular fatigue fractures.

Patterns of Fracture:

It is influenced by the resultant force which is applied at the moment prior to the fracture. In a normal physiological conditions, the resultant line force can be seen, one perpendicular to femoral neck axis, other in the line of axis of femur neck axis. If the resultant line of force alters at the moment before fracture. Then relative size of two components will be altered.

In 1950, frankel has shown experimentally a transverse fracture occurs if the ratio of bending component to compression component increases 1:6, if the ratio si 1:7, a subcapital fracture with spike occurs.

Classification of fracture neck of femur :

1. Anatomical
2. Gardens
3. Pauwels

4. AO classification

Anatomical classification :

It was first designed by sir astley cooper in 1823

It is based on the fracture line involves which part of neck

1. Subcapital fracture
2. Transcervical fracture
3. Basicervical fracture

Garden Classification :

Garden proposed this classification based on the displacement of fracture in the antero posterior view. Classified into 4 types

Type 1: incomplete fracture or impacted fracture. In this type of fracture, inferior neck trabeculae are intact. This group includes abduction impacted fracture.

Type II: It's a complete fracture without displacement. The trabeculae in the neck is disrupted

Type III: is complete fracture with partial displacement, the trabecular pattern doesn't not line with tarbeculae pattern of acetabulum. There will be breakage of trabeculae of the neck.

Type IV: is a complete and fully displaced fracture. The tarbecular pattern of head is in alignment with the acetabular tarbecular pattern.

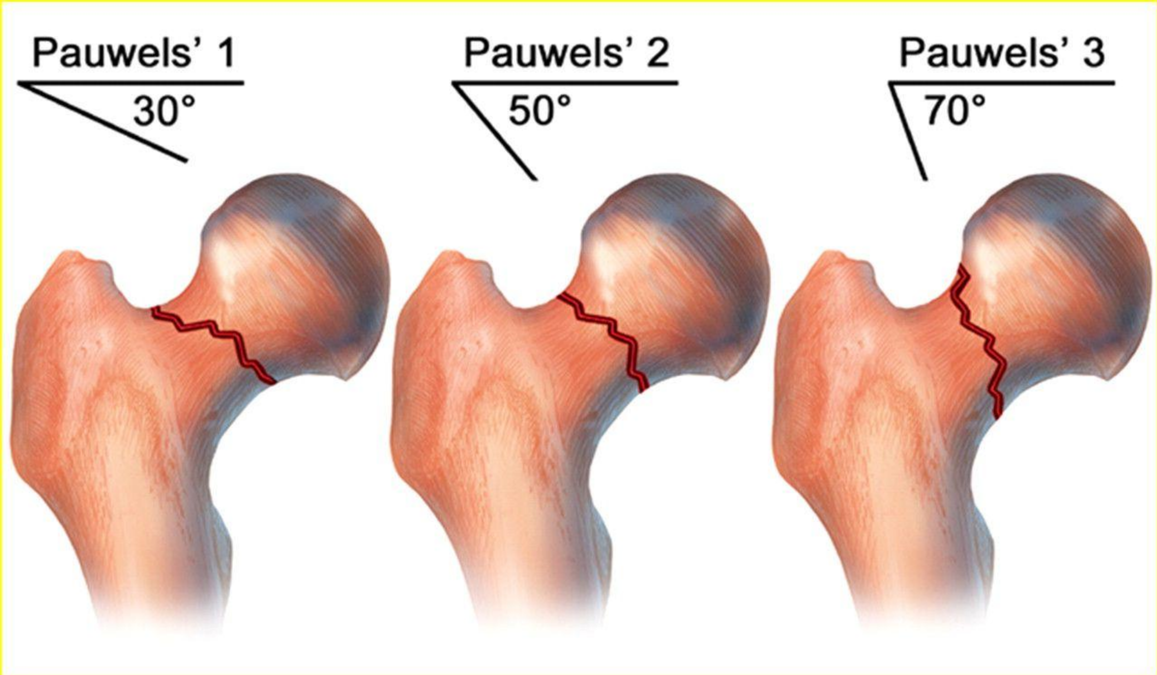
Eliasson – eiskjaer and ostgard and recently kreder demonstrated that there is no big difference in outcome and management , when classified based on fracture and displacement.

Pauwels Classification: based on fracture angle

Pauwels divided femoral neck fractures based on the direction of fracture line across the femoral neck into three types.

- Type - I is a fracture 30° from the horizontal
- Type - II is a fracture 50° from the horizontal
- Type III is a fracture 70° from the horizontal.

Type I fractures are much more horizontal than type III fractures, which are almost vertical. Pauwels attributed nonunion in type III to the increased shearing force of this vertical fracture.



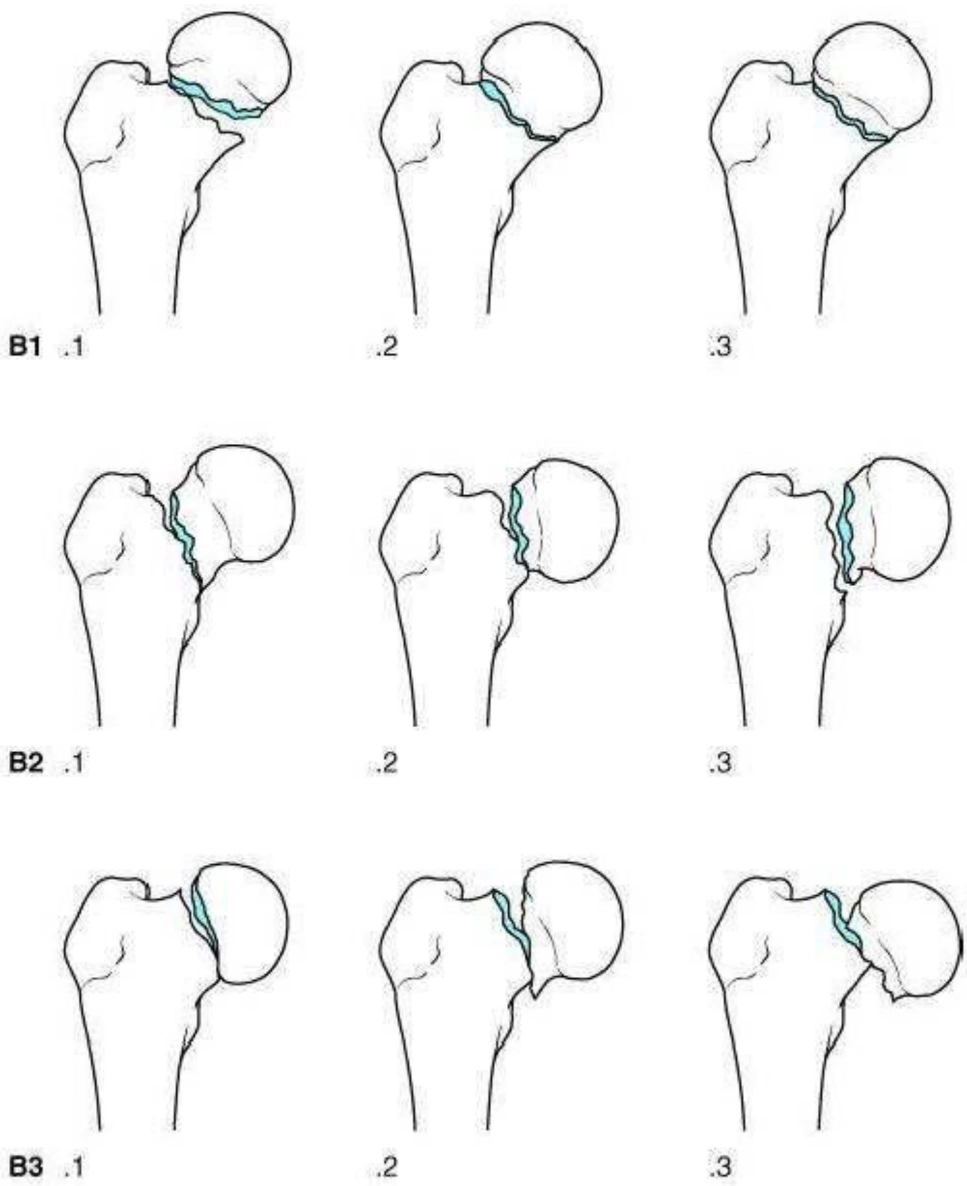
AO classification :

It is universal classification. For femur tha alphanumeric is 31B, in which 3 stands for femur, 1 for proximal femur, B for neck fractures, further classified on the anatomical site and fracture patterns.

- 31-B1- subcapital fracture
  - ✓ 31 -B1.1 – impacted in valgus > 15 degrees
  - ✓ 31-B1.2- impacted in valgus < 15 degrees
  - ✓ 31- B1.3- non impacted fracture.
- 31- B2- transcervical fracture
  - ✓ 31-B2.1 – basicervical fracture

- ✓ 31-B2.2- midcervical adduction
- ✓ 31- B2.3- midcervical shear

- 31- B3 – displaced, non impacted subcapital fractures.
  - ✓ 31-B3.1- moderate displacement in varus and external rotation
  - ✓ 31-B3.2- moderate displacement with vertical translation and external rotation
  - ✓ 31-B3.3- marked displacement in varus with translation



Clinical features of fracture neck of femur : [2,23]

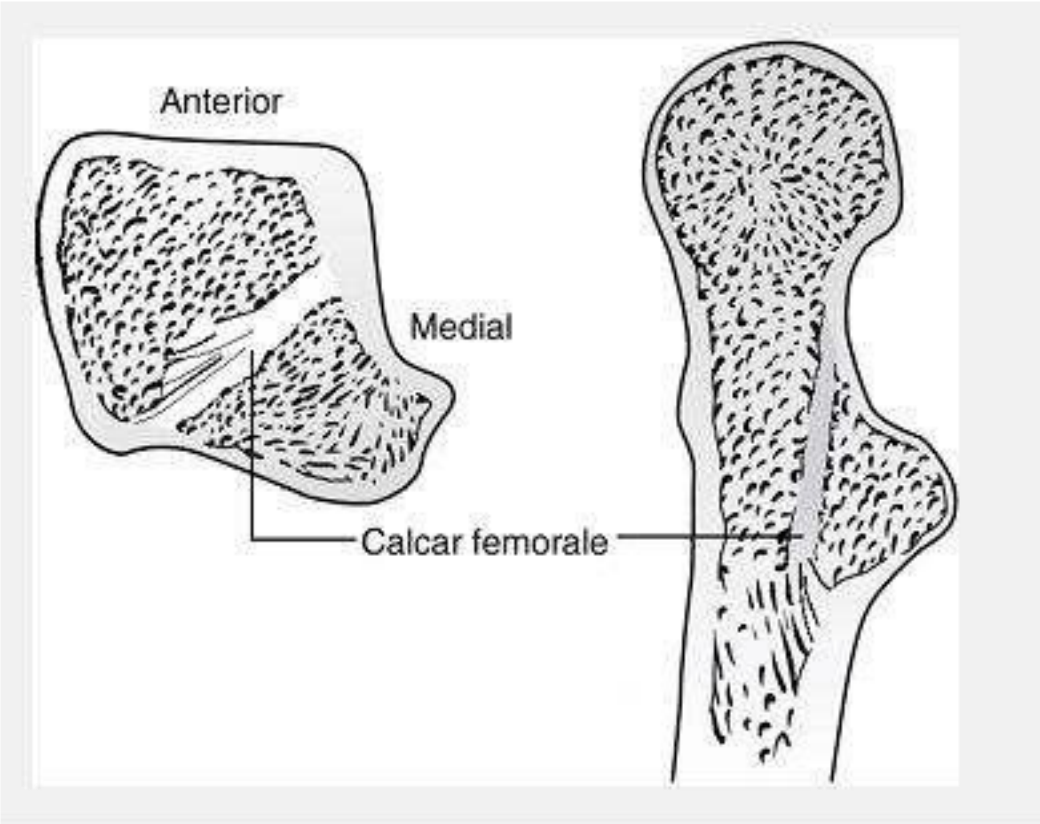
The classical picture will be pain in the groin often referred to inner thigh and knee. Movements of the hip and whole will be painful and severely restricted with spasms. Greater trochanter will be migrated upwards with crepitus on movements. The injured limb will present with shortening and external rotation. In impacted fracture sometimes patient can move his limb or even walk with pain and limp. Quite often there will be external rotation deformity

Roentgenography of the hip region :

The routine x ray evaluation which includes anteroposterior view of pelvis, true anteropsoterior view with traction and maximum internal rotation and cross table lateral view. The hip joint is usually radiographed with heel slightly separated and toe symmetrically directed forwards and medially. In this position femur is rotated medially, the femoral neck is parallel to the film. The shadow of the upper end of femur and acetabular region is clearly seen. A curved white line of cortical bone delinates the superior and medial edge of acetabulum and the cortex of head also appears as white line. The joint space is measured by the gap between the white line of head of femur and acetabulum. Normal space is in adults about 4-7mm. the appearance of neck, greater trochanter, lesser trochanter are altered by the rotation of thigh. When foot directed slightly medially, neck lies in transverse plan, when foot is directed anteriorly, greater trochanter lies in posterior to head of femur, if foot directed outwards, greater trochanter still moves posterior, neck shortened. The angle between neck and shaft is best seen when x ray taken on limb with internal rotation of about 15 -20 degrees. The angle is usually 120- 140 degrees.

Calcar femorale :

According to Harty [94] and Griffin[95], the calcar femorale is a dense vertical plate of bone extending from the postero-medial portion of the femoral shaft under the lesser trochanter and radiating lateral to the greater trochanter, reinforcing the femoral neck posteroinferiorly. The calcar femorale is thicker medially and gradually thins as it passes laterally The presence and adequacy of Calcar femorale can be best appreciated by an AP view of the hip taken in 15^0 internal rotation.

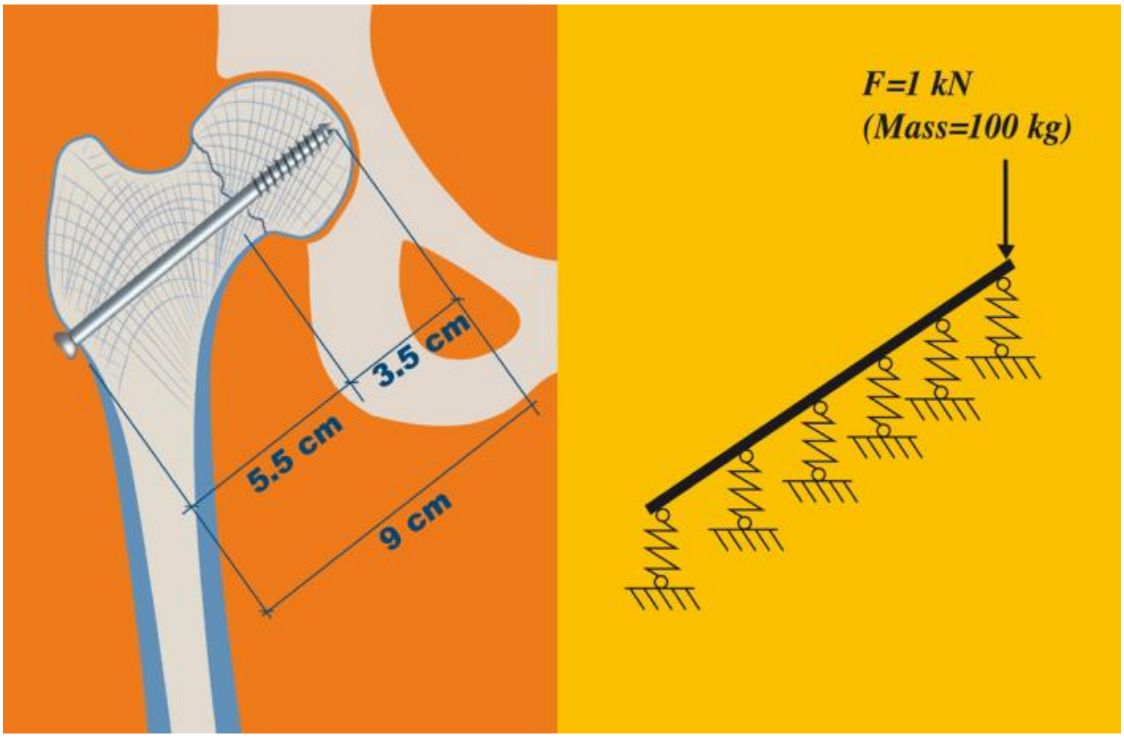


Biomechanical basis of the BDSF-method

This method's innovation is laying of the three screws in two planes, which allows for the entry points of two of the implants to be placed much more distally, in the solid cortex of the proximal diaphysis, and also to lean onto the femoral neck distal cortex. Thus we establish two points of support. The solid distal cortex of the femoral neck acts as a medial supporting point for the screws, which works under pressure - supporting point A. The entry points of two of the screws (the distal and the middle one) in the thick cortex of the diaphysis, ensure a second solid supporting point for the screws – a lateral one, which works under tension (or pressure in proximal direction) - supporting point B.

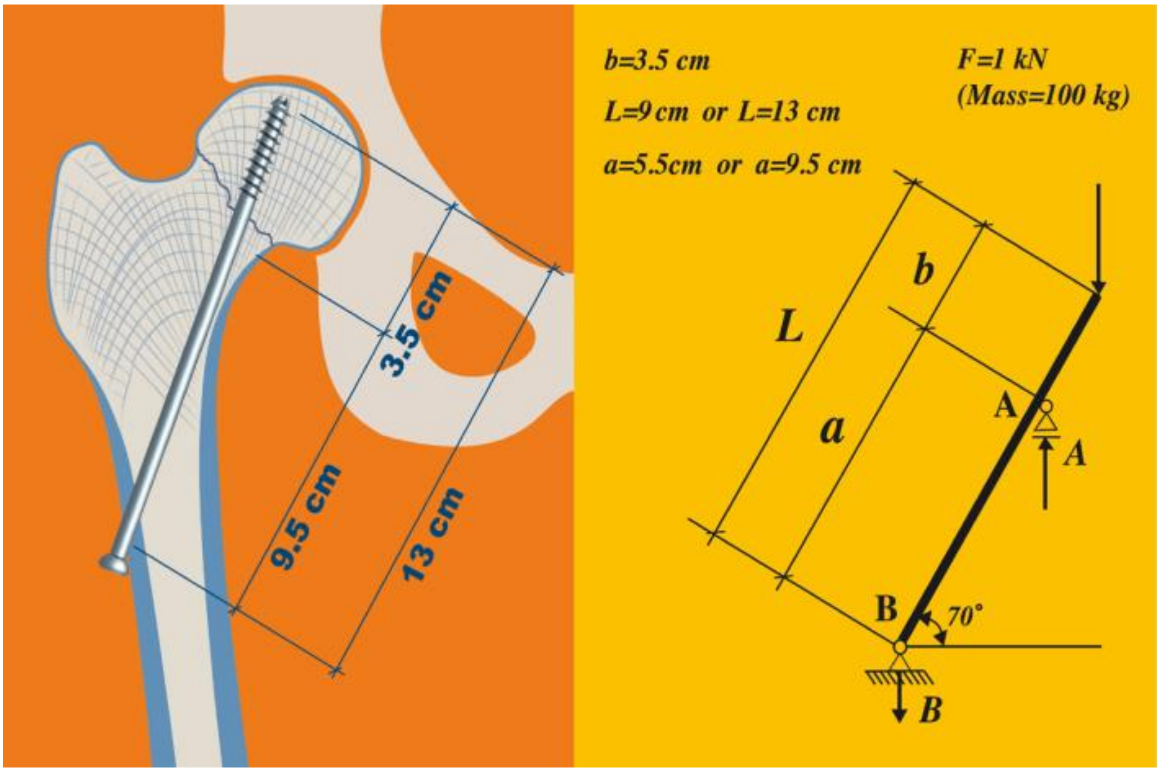
The position of the distal screw as well as of the middle screw, which are achieved by the method, in terms of the statics, turns them into a simple beam with an overhanging end, loaded by a vertical force. This beam with an overhanging end successfully supports the head fragment, bearing the body weight and transferring it to the diaphysis. Furthermore, due to the biplane placement, enough space for a third screw is provided, unlike the classic authors' models, where just one or maximum two implants are placed at an obtuse angle . Another advantage of the method is that due to the increase in the distance between the two supporting points, the weight borne by the bone is significantly reduced. An advantage of the BDSF-method is that the entry points of the screws are positioned wide apart from each other, which ensures that upon weight bearing, the tensile forces spread over a greater surface of the lateral cortex and thus the risk of its fracturing decreases significantly. Another advantage with the BDSF is that the screw, placed at a highly increased angle, works in a direction close to the direction of the loading force, which guarantees better results for the screw in its role as a beam because the influence of its sagging decreases.

With the conventional methods of femoral neck fixation - by three cancellous screws, placed parallel to each other and parallel to the femoral neck axis, the entry points of the three screws are placed at the thin, fragile cortex of the greater trochanter or close to it. The screws are often located near the axis of the femoral neck in the soft cancellous bone, without any cortical support. With conventional methods, due to the lack of two solid supporting points, the implant acts statically like a beam on an elastic foundation. The elastic foundation is implemented by the soft cancellous bone.



Static model of the conventional methods of fixation – the implant acts statically like a beam on an elastic foundation. F = load

In contrast to the conventional methods, when the Biplane double-supported screw fixation - method is applied, the implant is additionally supported at points A and B of the cortex. The interaction between the implant and the cancellous bone is neglected, because of the comparatively small stiffness of the cancellous bone. In this way, with enough practical accuracy, with the BDSF-method, the static model is considered to be a simple beam with an overhanging end. This beam is supported at points A and B only.



Static model of the new BDSF-method of fixation – the implant acts like a simple beam with an overhanging end. F = load; L = length of beam; a = distance between points A and B

The load acting at point A is pressure in a distal direction and it equals to A=FL/a; The load acting at point B is pressure in a proximal direction and it equals to B = A – F. At the BDSF-method, due to the increase in the distance between the two supporting points, the weight borne by the bone is reduced. If we look at two cases of equal vertical weight but different distances between the supporting points, we will see that the greater the distance, the smaller the weight at each of the two supporting points. The average anatomical distance from the tip of the screw to the distal femoral neck cortex curve (point A) is 3.5 cm. With conventional methods (case 1.) the average distance from point A to the entry point of the screws in the lateral cortex (point B) is 5.5 cm (a = 5.5 cm). In order to make a comparison with the BDSF, when body weight of 100 kg is given, with conventional methods the load acting on the curve of the femoral neck distal cortex (if the screws lean on this support at all) is estimated as

A equal to 163.63 kg. The load on the fragile lateral cortex (point B) is estimated as B equal to 63.63 kg, directed in the opposite direction (proximally).

With the BDSF method, with increasing the angle of the implant towards the diaphysis, the distance between points A and B increases by 4 cm to reach up to 9.5 cm (a = 9.5 cm). That is why, the load on the cortex decreases significantly. Given the same body weight of 100 kg, the load acting on the medial supporting point is estimated as A equal to 136.84 kg or with 16.38% less than conventional methods, and on the lateral supporting point the load is estimated as B equal to 36.84 kg or with 42.11% less than conventional methods. The distal screw normally applied with the BDSF method has a length of 13 cm. It is subjected to compressive stress in a proximal direction, and to horizontal tensile stress as well. In the lower part of the cortex the stress is mainly tensile.

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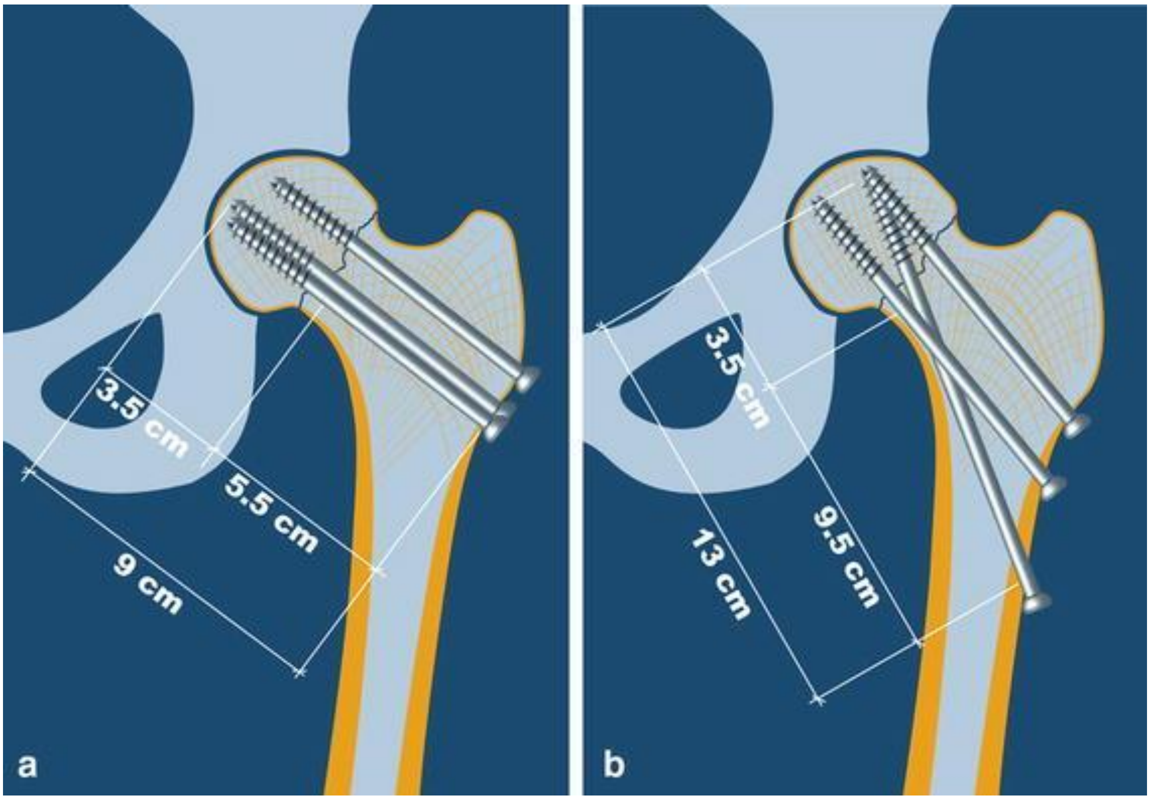
Fixation of the femoral neck: a. Conventional method; b. The BDSF-method.



As it was mentioned, these forces of tension are decreased by 42% with the BDSF-method, compared to the conventional methods of fixation. Besides, with the BDSF-method the entry points of the screws are located wide apart from each other (from 2 to 4 cm), which leads to dispersion of the tension stress on the lateral cortex over a wide surface and decrease of the fracture risk, contrary to the conventional methods, with which the entry points of the screws are at a distance less than 1 cm from each other and the forces of tension are concentrated over a small surface.

MATERIALS AND METHODS

Study was conducted in Government Royapettah Hospital, Kilpauk Medical College and the study period was August 2015 to September 2017. This study was conducted to analyse the functional and radiological outcome of femoral neck fractures fixed using BDSF method

INCLUSION CRITERIA

- Patients more than 18 years of age with neck of femur fractures.
- All types of femoral neck fractures (garden types 1-4) including posterior wall comminution.
- Patient with no other associated fractures

EXCLUSION CRITERIA

- Fractures with non union changes in neck of femur
- Patients with arthritic changes of hip joint
- Pathological fractures

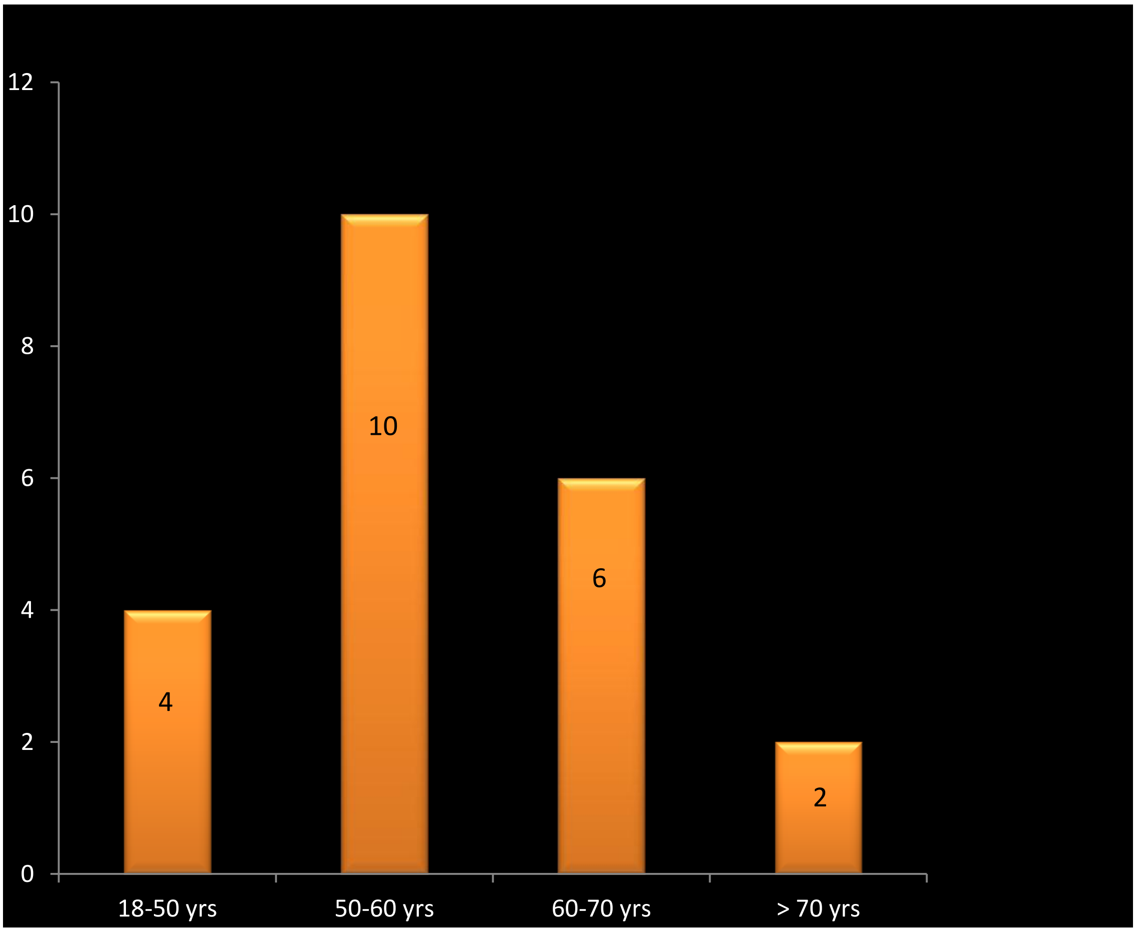
We had 22 cases of femoral neck fracture, out of which 20 cases were followed up regularly.

OBSERVATION

The following observations were made in the study as following:

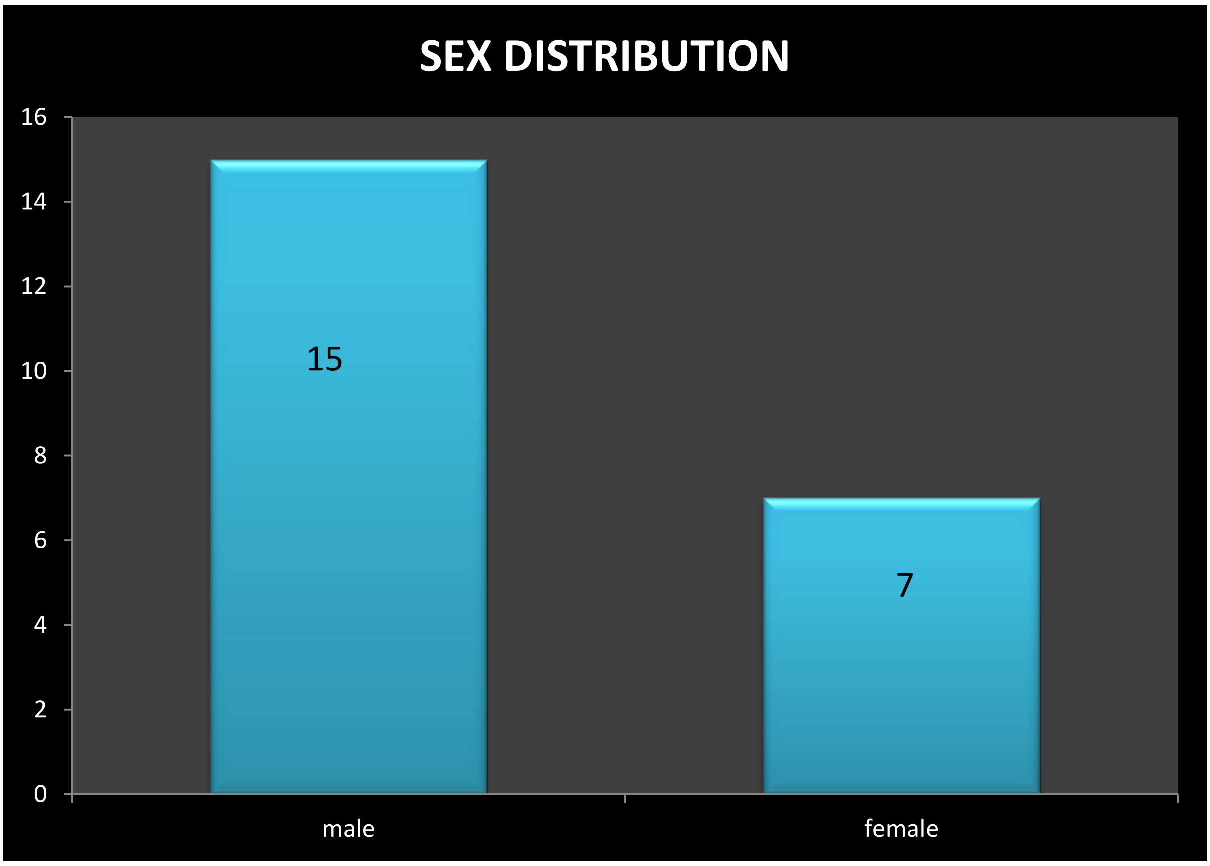
AGE DISTRIBUTION

In our study majority of the patients were in the limit of 50-60 yrs with mean age of 56.5 yrs . The youngest was 18yrs and the oldest was 72



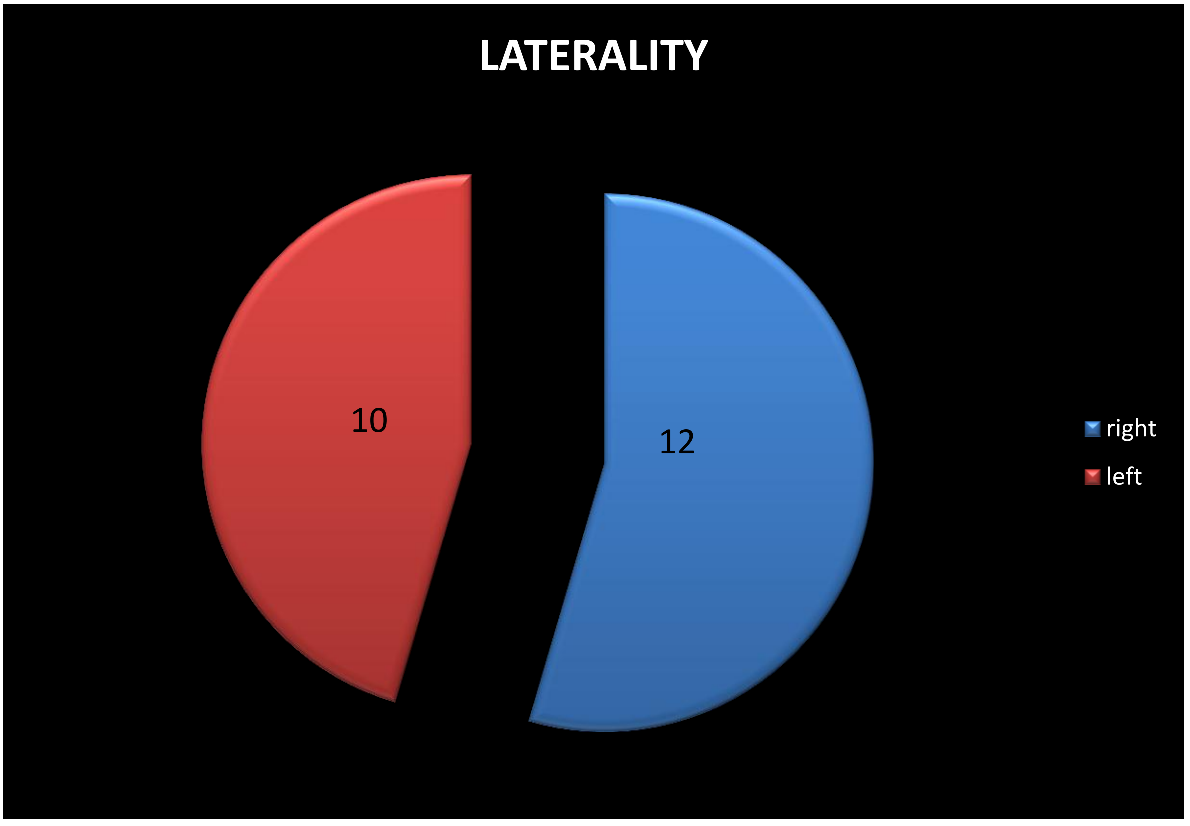
SEX DISTRIBUTION

In our study, the total no. of male patients were 15 (68.18%), female patients were 7 (31.81%).



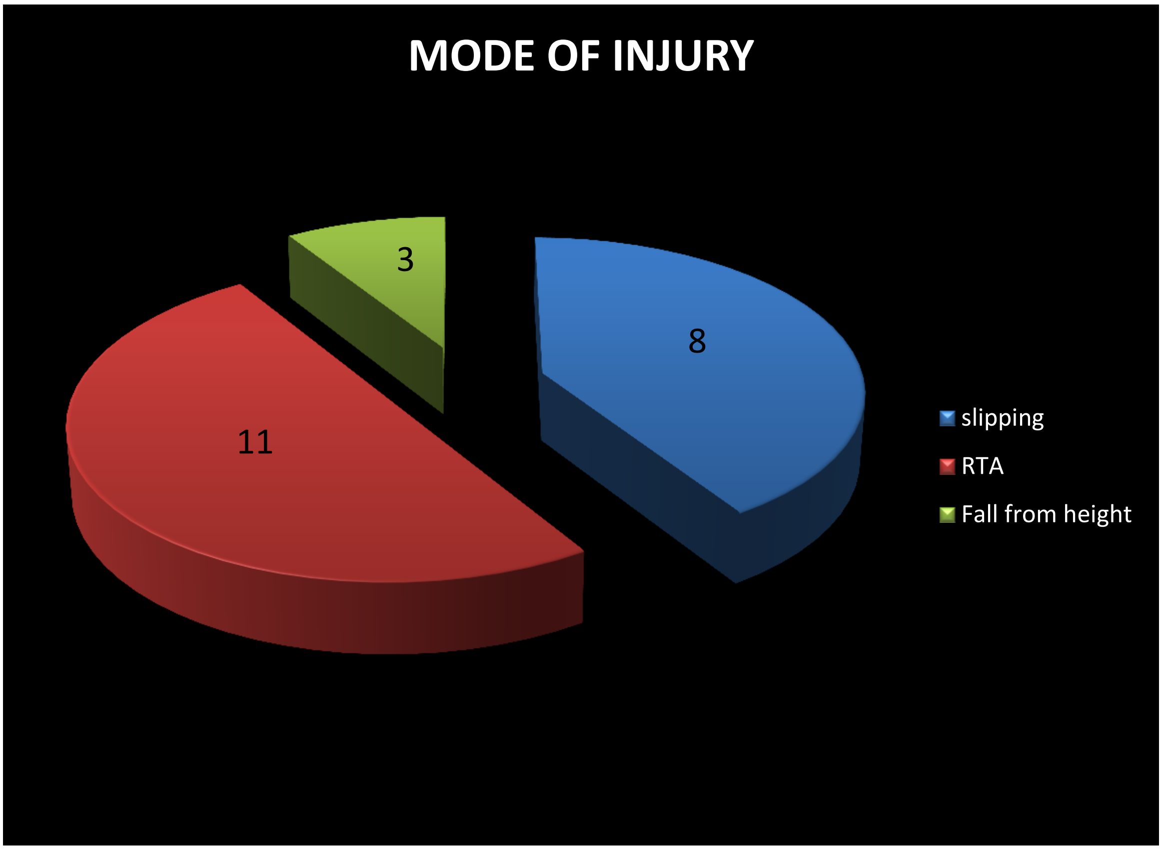
LATERALITY

12 patients (54.54%) had fracture on right side while the remaining 10 (45.45%) had on left side



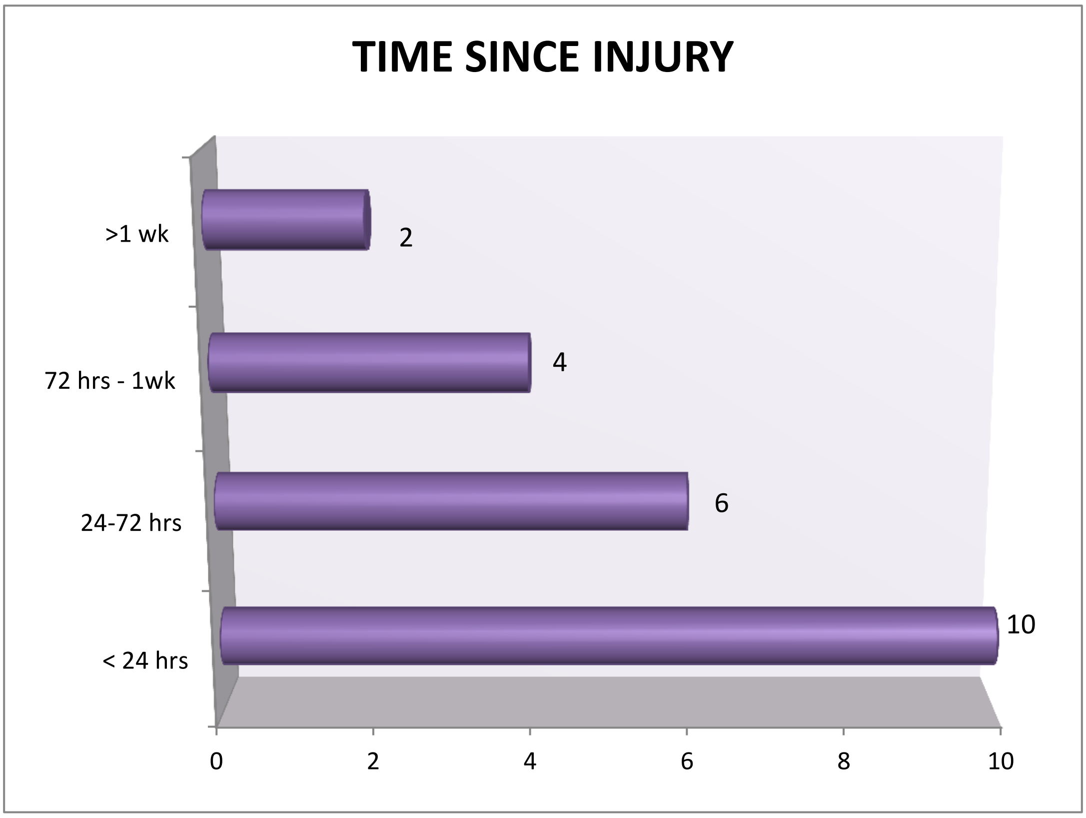
MODE OF INJURY

The following digram depicts that the mode of injury was RTA in 11 patients, followed by slip and fall in 8 patients and fall from height in 3 patients



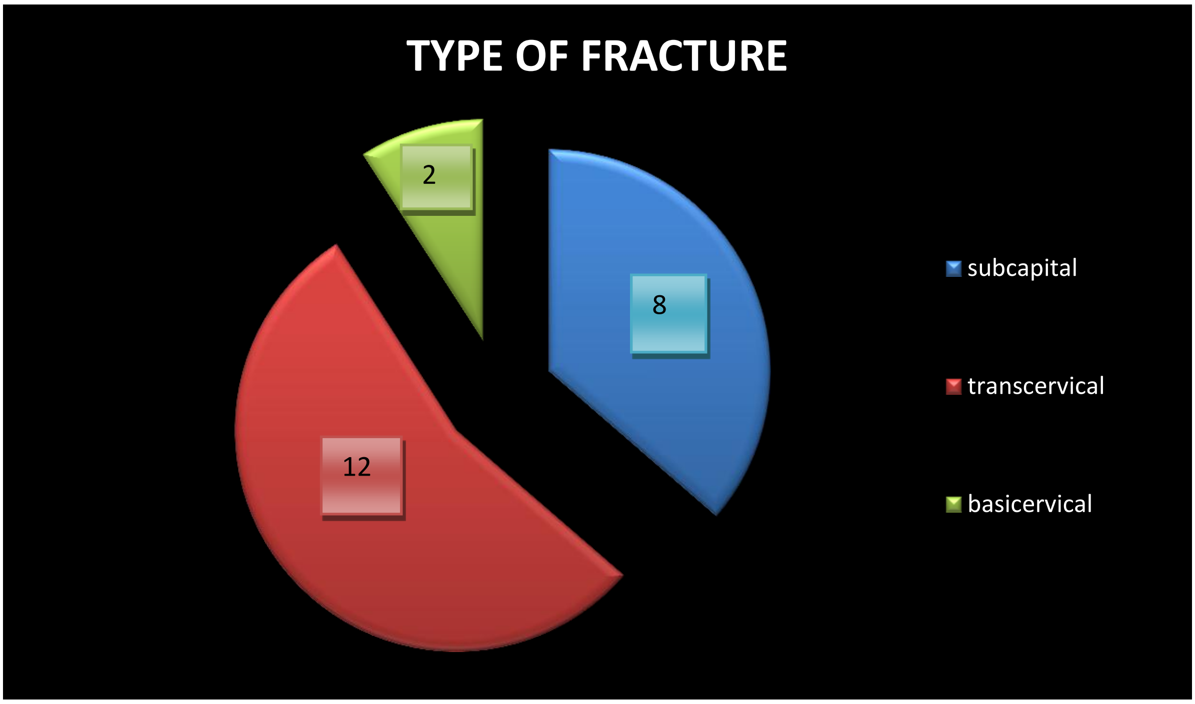
TIME OF PRESENTATION AFTER INJURY

In our study 10 patients (45.45%) presented within 24 hrs of injury, 6 patients (27.27%) presented within 24-72 hrs, 4 patients (18.18%) from 72hrs to 1 week, 2 patients (9.09%) after 1 week



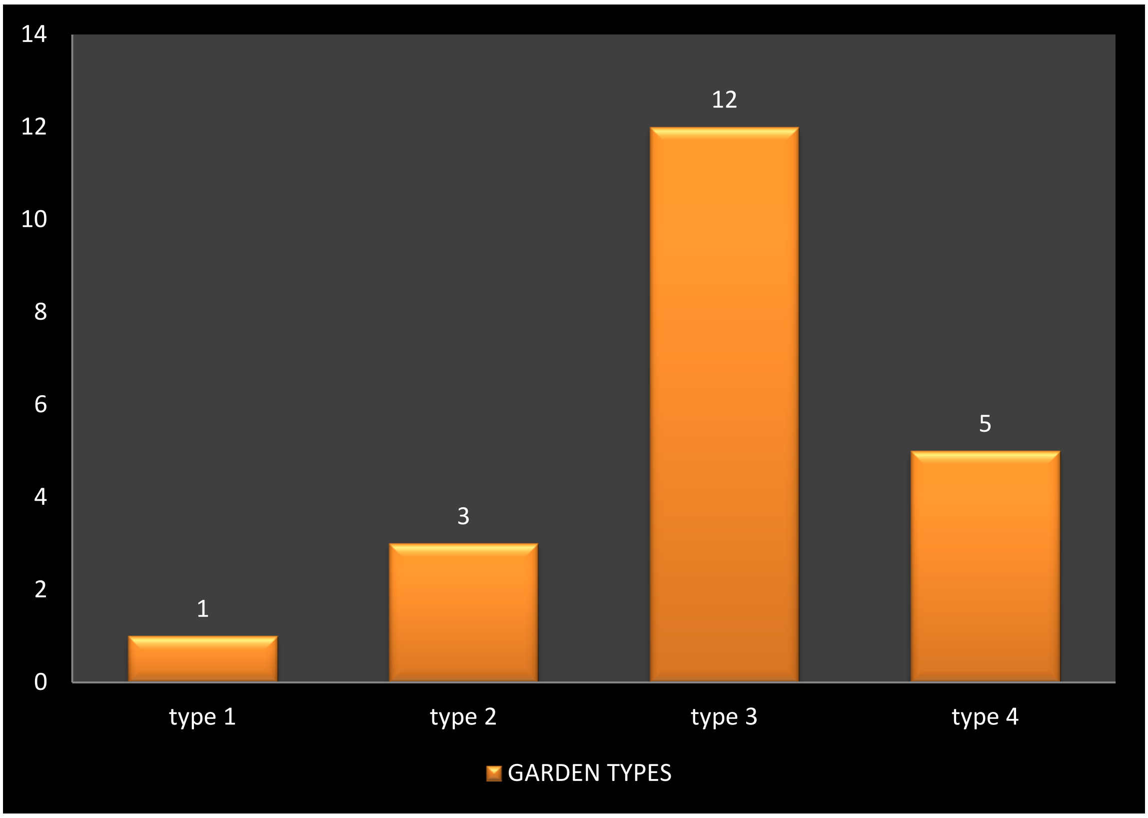
ANATOMICAL TYPE OF FRACTURE

The following diagram shows that most of the fractures were transcervical in 12 patients (54.54%), while 8 (36.36%) were subcapital, 2 (9.09%) were basicervical



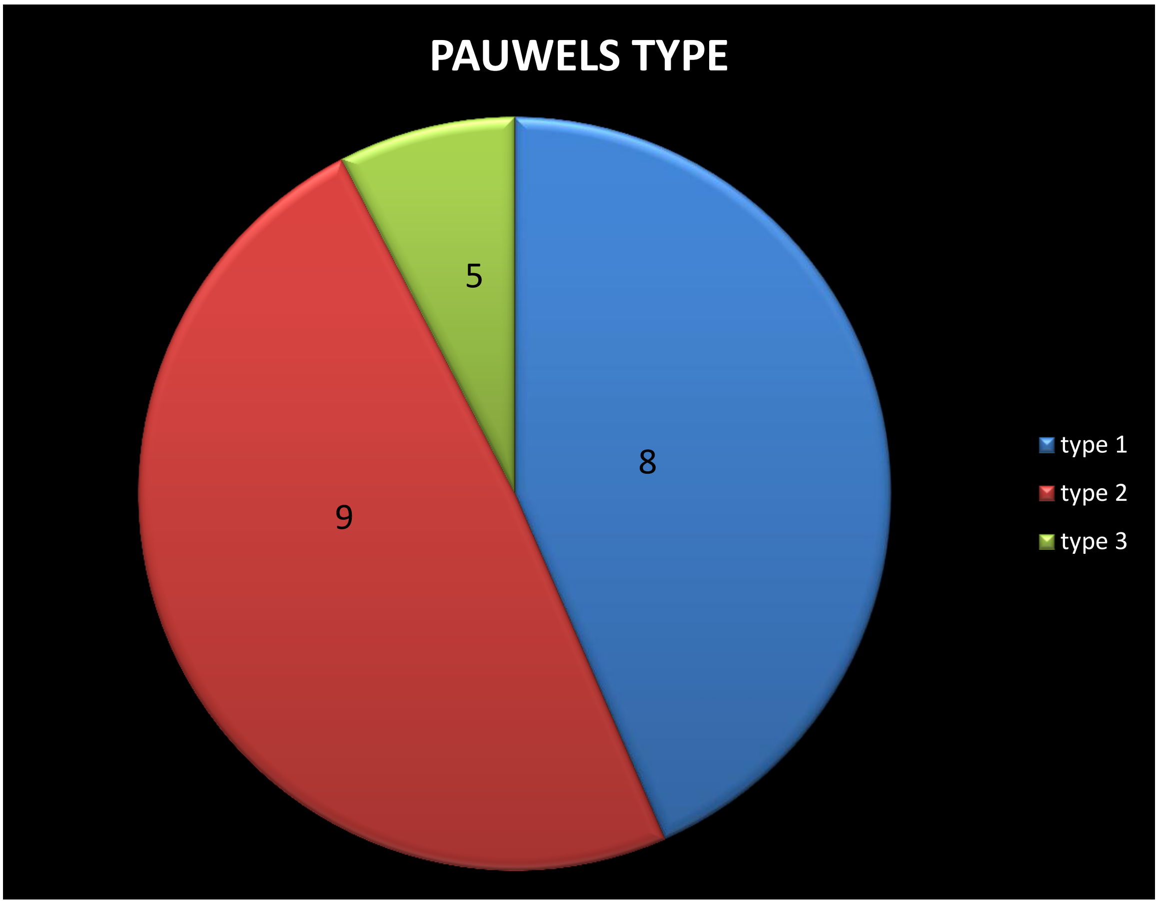
GARDEN TYPES

Most of the patients (12 cases) sustained type 3 garden, followed by type 4 garden in 5 cases, then type 2 in 4 cases, and type 1 in 1 case.



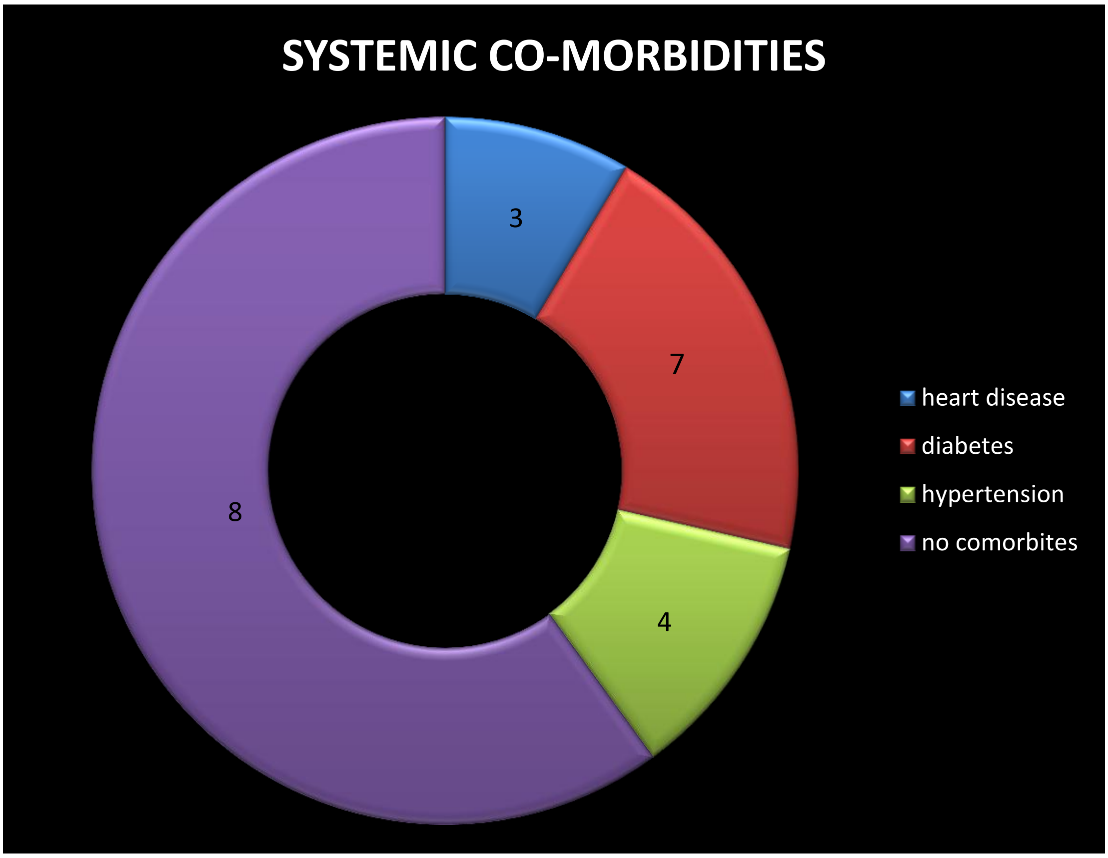
PAUWELS TYPES

Majority of fractures were pauwels type 2 (40.9%) in 9 cases, followed by type 1 (36.36%) in 8 cases, then type 3 (22.72%) in 5 cases



SYSTEMIC CO-MORBIDITIES

Out of 22 patients, 7 patients had diabetes, 4 patients had hypertension, 3 patients had heart problems .



PREOPERATIVE PROTOCOL

All study patients were put on either derotation boot or non adhesive skin traction. Adequate medical management of associated co-morbid conditions like Diabetes Mellitus, Systemic Hypertension, Chronic Obstructive Pulmonary Disease and Heart Diseases were initialized to optimize patient’s fitness for anesthesia. An informed written consent for the procedure as per the guidelines of the institution and a consent for inclusion of the patient for the present study were taken. The involved lower limb was prepared on the day before surgery. The peri-operative antibiotic used was Cefotaxime given 1 gm 12^{th} hourly intra-venous starting 30 minutes before the procedure. Preoperatively CT scan were taken for all patients to find out posterior wall comminution,

TIMING OF SURGERY:

20 patients were operated on 3^{rd} or 4^{th} day depending on their co-morbid condition, while 2 cases which presented late were operated on 10^{th} day .

SURGICAL PROCEDURE

All cases were done under regional anaesthesia which included spinal or epidural anaesthesia.

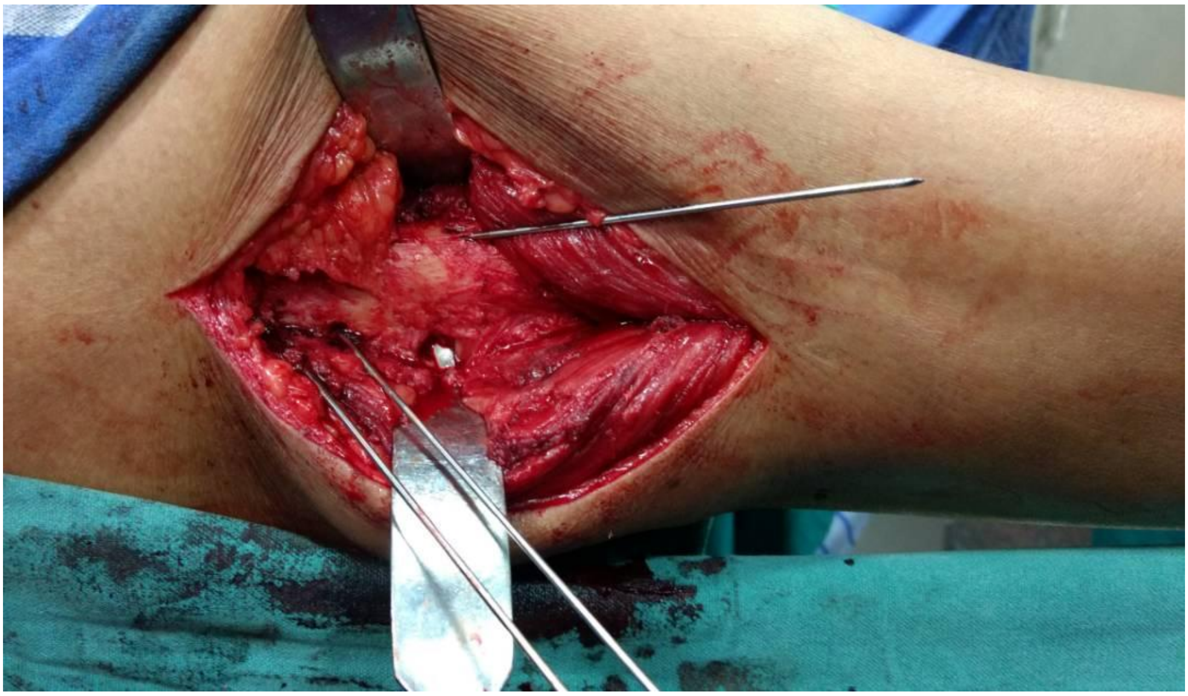
POSITION : all patients were positioned on fracture table.

REDUCTION: In all patients anatomical or near anatomical reduction was achieved by lead better technique except in 1 case where open reduction was done.

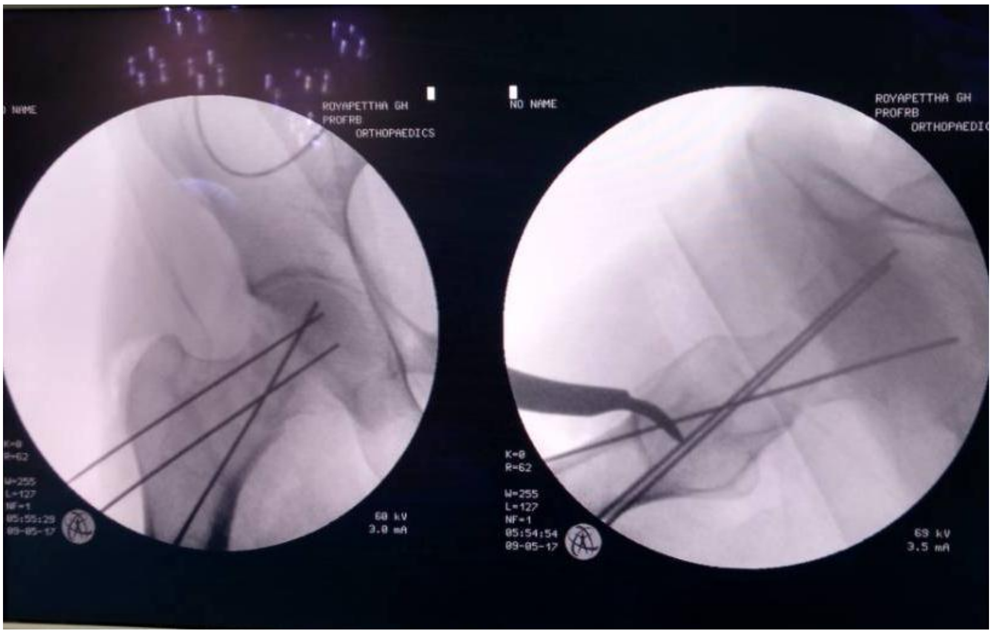
IMPLANT USED: 6.5 mm Cannulated Cancellous Screws

PRE OP POSITIONING ON FRACTURE TABLE

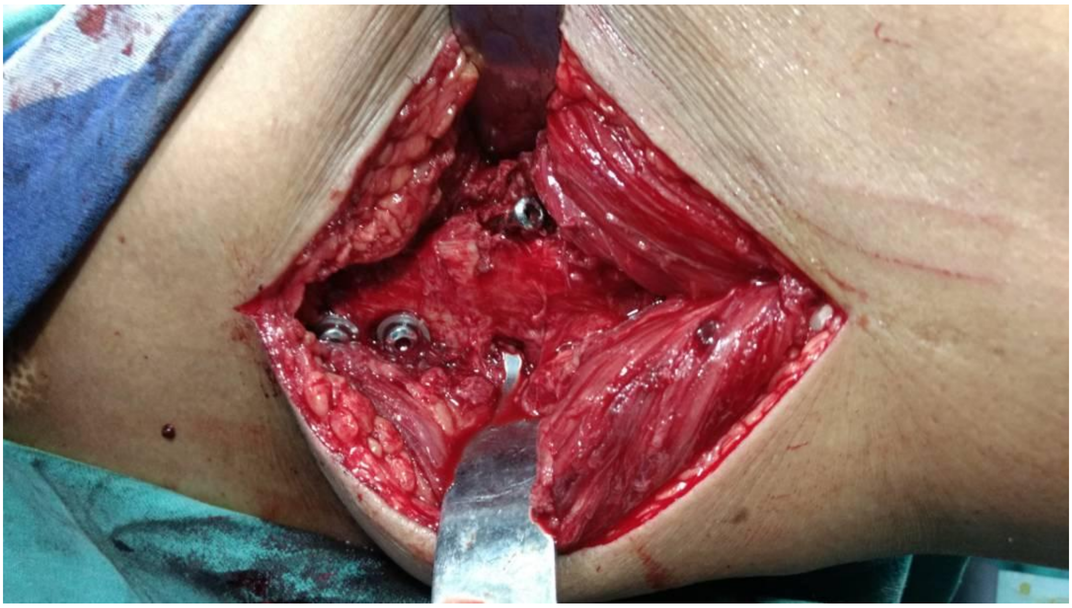
Approach: A straight lateral incision, starting at the level of lower border of greater trochanter, with distal length of 6 to 10 cm. First, we lay the guide wire for the distal cannulated screw. Its entry point is at 5-7 cm distally from the lower border of the greater trochanter, directed at an angle of 150 – 165°, with inclination to posterior-proximal, so that after it touches the “calcar” tangentially, the wire goes into the posterior third of femoral head. Thus the wire also comes naturally in contact with the posterior neck cortex. The middle guiding wire is placed second with entry point 2 to 4 cm proximally from the distal wire at an angle of 135-140^0 and is inclined to anterior-proximal, so that after it touches onto the calcar tangentially, the wire goes into the anterior one-third of the femoral head. Then we place the proximal guiding wire, with its entry point at 1.5-2 cm proximally from the middle wire and parallel to it. Then reaming was done and then cannulated cancellous screws application was done as shown in the picture.



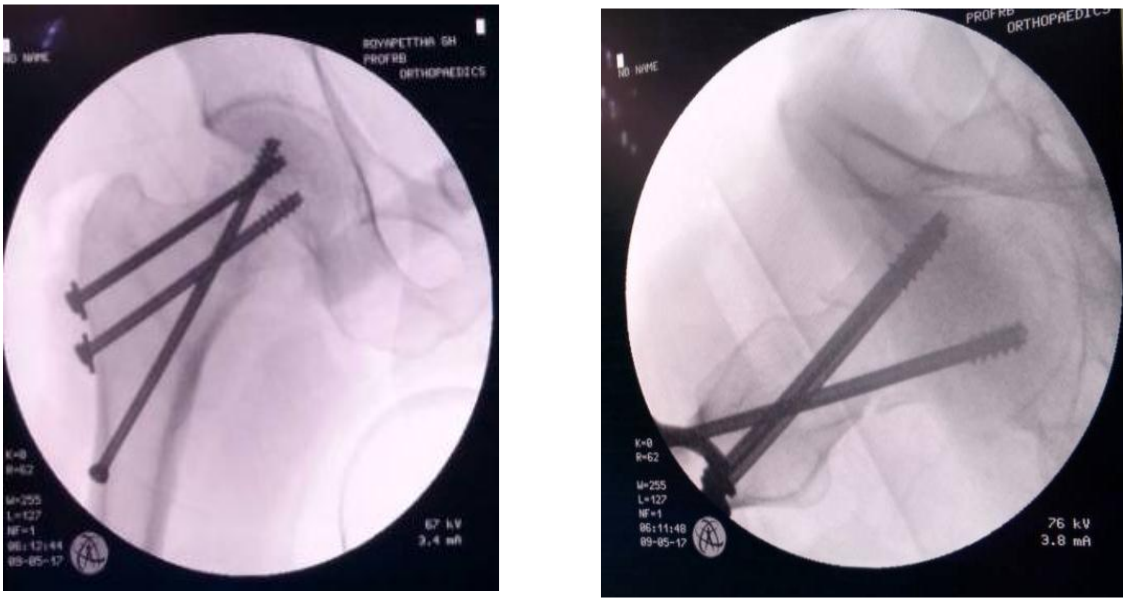
INTRAOP POSITIONING OF GUIDE WIRE



The middle and proximal screws are placed first because they are perpendicular to the fracture surface. Finally, the distal screw is placed.



INTRAOP PICTURE OF CANCELLOUS SCREWS



INTRAOP C-ARM PICTURE-AP & LATERAL VIEW

Later wound closure was done in layers and followed by sterile dressing .

POSTOPERATIVE PROTOCOL

Post operatively intravenous antibiotic Cefotaxime 1 gm was given 12th hourly and was continued for the first 5 days. The wound was inspected at the time of drain removal on 2nd post op day and alternate day sterile dressing done. Suture removal was done on 14 th day.

- Passive knee mobilisation exercises and quadriceps strengthening exercises were advised immediately on first post op day.
- Non weight bearing for period was advised for 6 weeks from the day of surgery.
- Later after 6 weeks active hip mobilisation exercises and partial weight bearing was allowed after reviewing follow up x rays of the patient
- Later full weight bearing allowed after radiological union was seen.

FOLLOW UP

Out of 22 patients, 20 were followed up regularly every month till 6 months and then every two months. The minimum follow up in our study was 6 months and the maximum follow up was 24 months. During the follow up period, functional outcome were assessed using Harris hip score after radiological union.

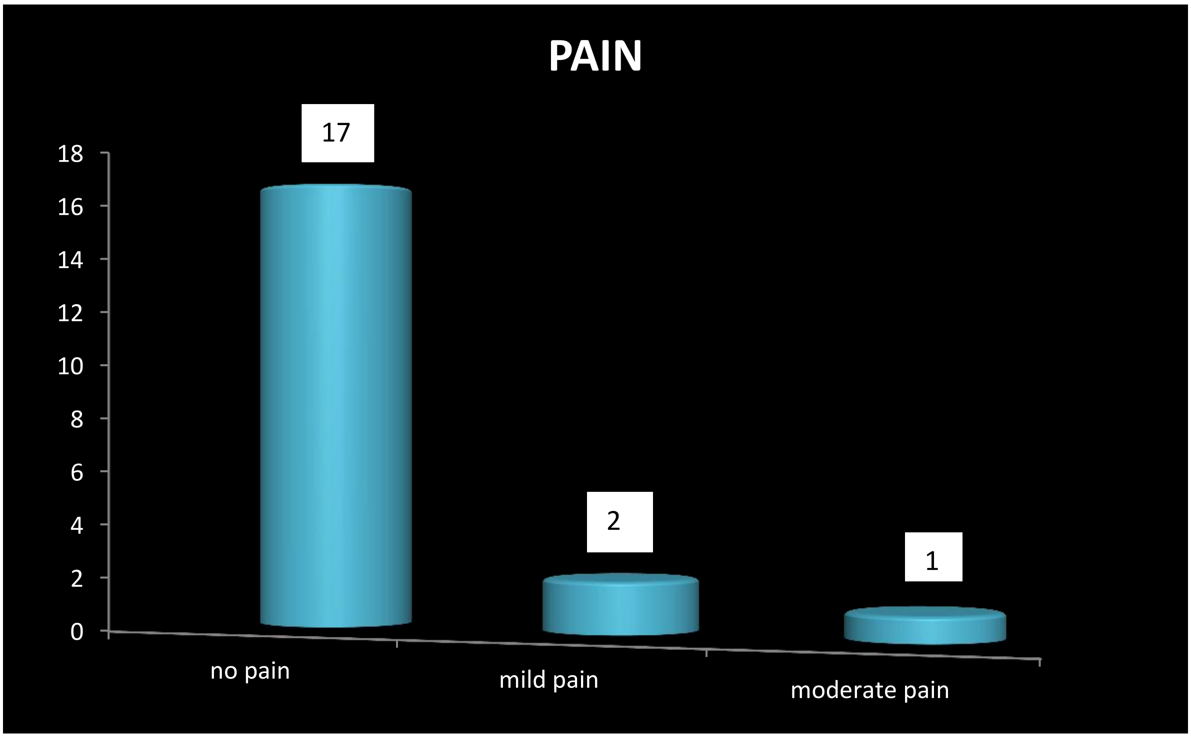
ANALYSIS

In our study Harris hip score was analysed in all patients based on maximum follow up achieved by the individual. Analysis of Harris hip score was done in 20 patients.

ANALYSIS OF HARRIS HIP SCORE

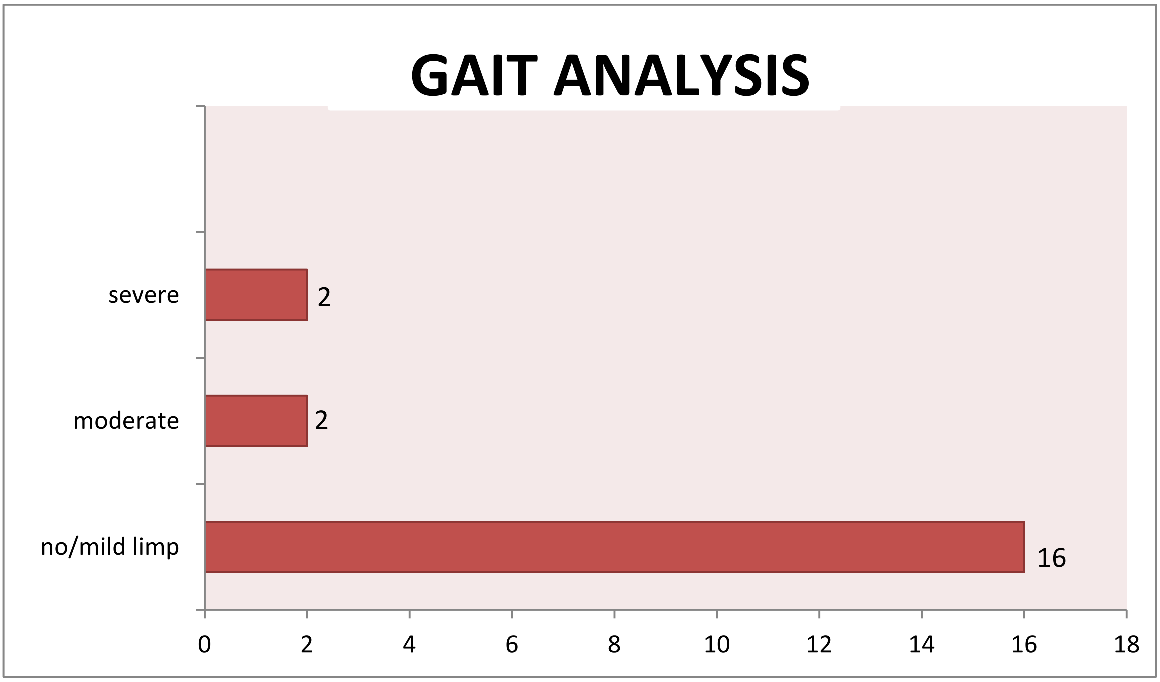
PAIN

In our study out of 20 patients, 17 (85%) were pain free, 2 (10%) patients had mild pain, and 1(5%) patient had moderate pain.



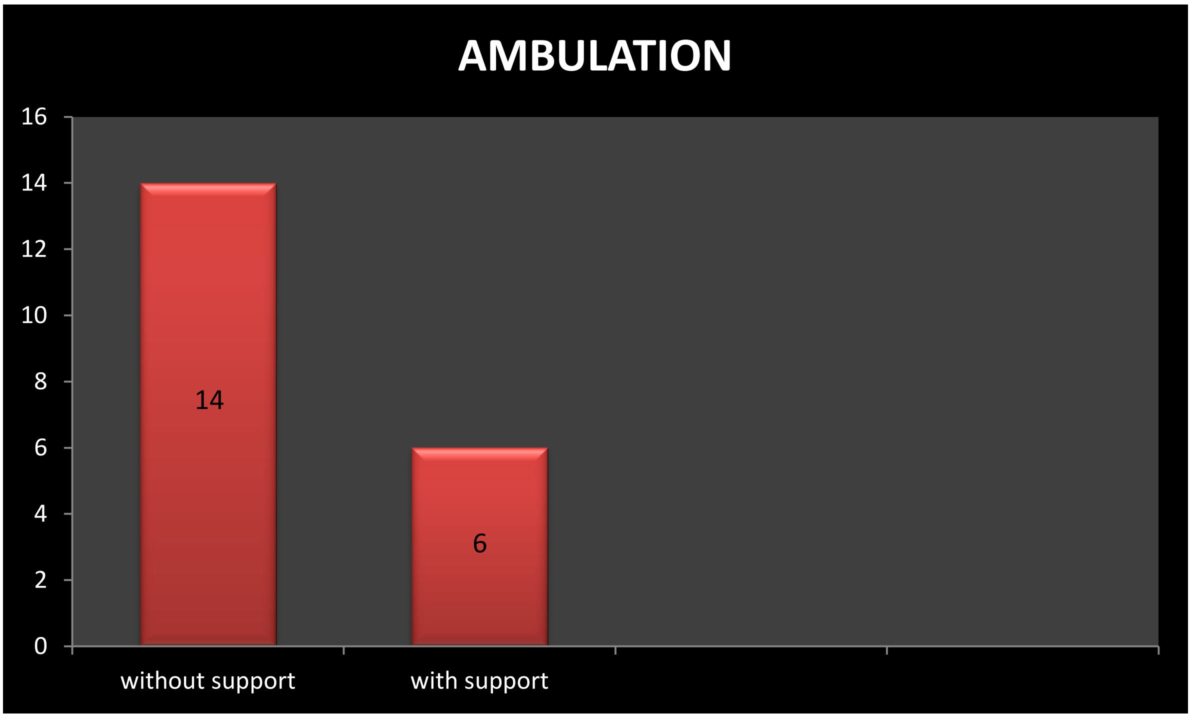
GAIT ANALYSIS

In our study, 2 (10%) patients had moderate limp, 2 (10%) had severe pain while 16 patients had mild limp or no limp.



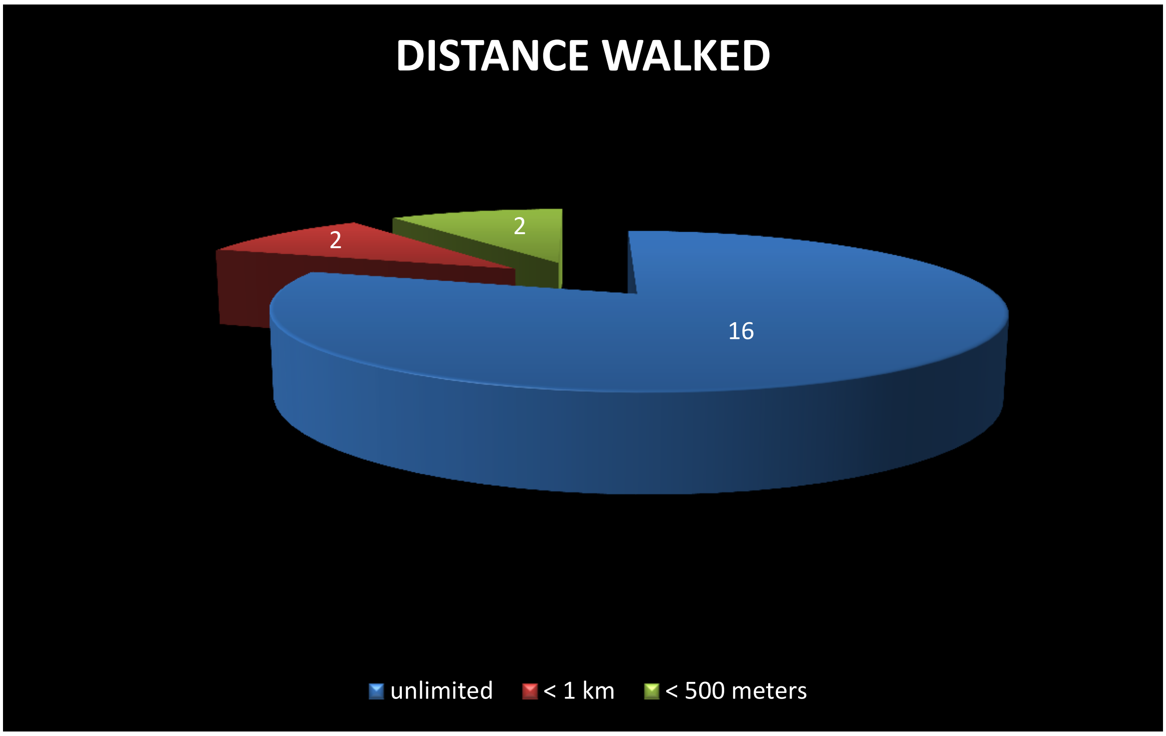
AMBULATION

14 patients (70%) were found to be ambulating without the help of any support and the remaining 6 patients (30%) needed some support in the form of a cane or walker for long walks



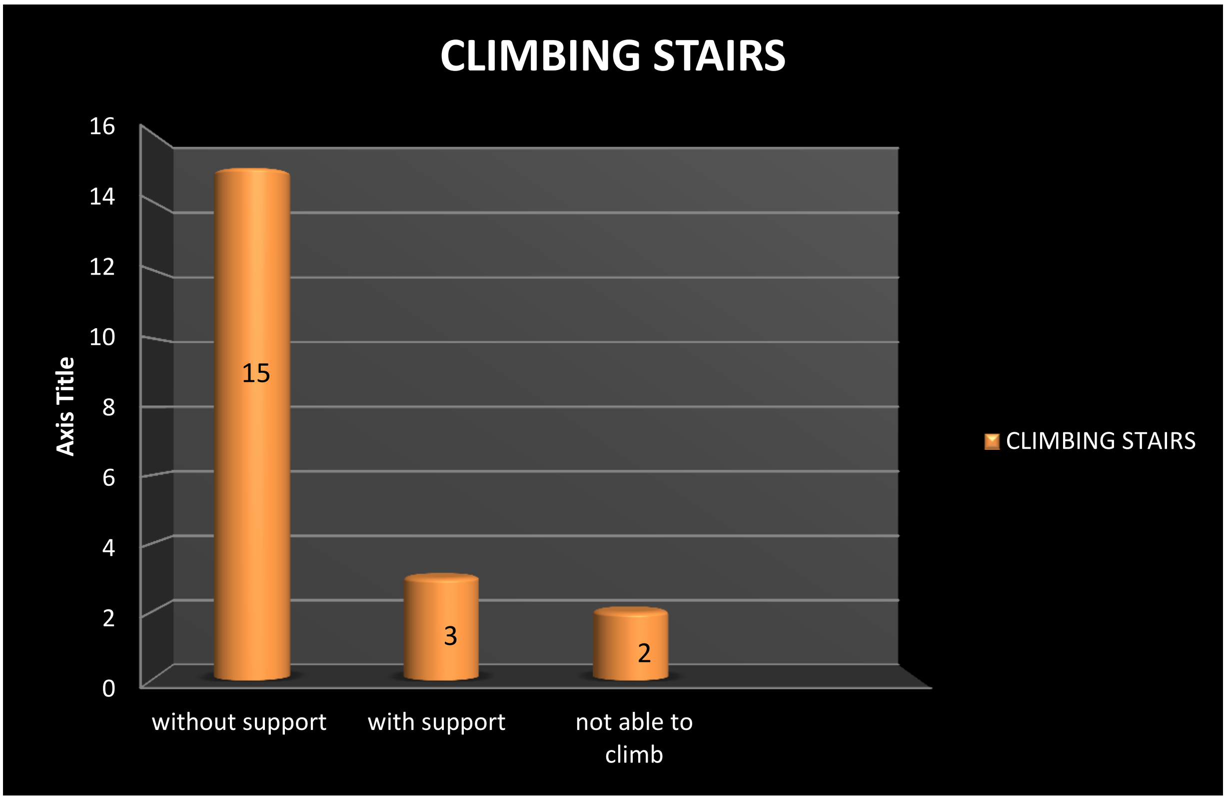
DISTANCE WALKED

16 (80%) of the study patients could walk an unlimited distance at any given point of time while 2 patients (10%) could walk no more than 1000 meters at a time and 2 patients (10%) could only manage 500 meters at a time



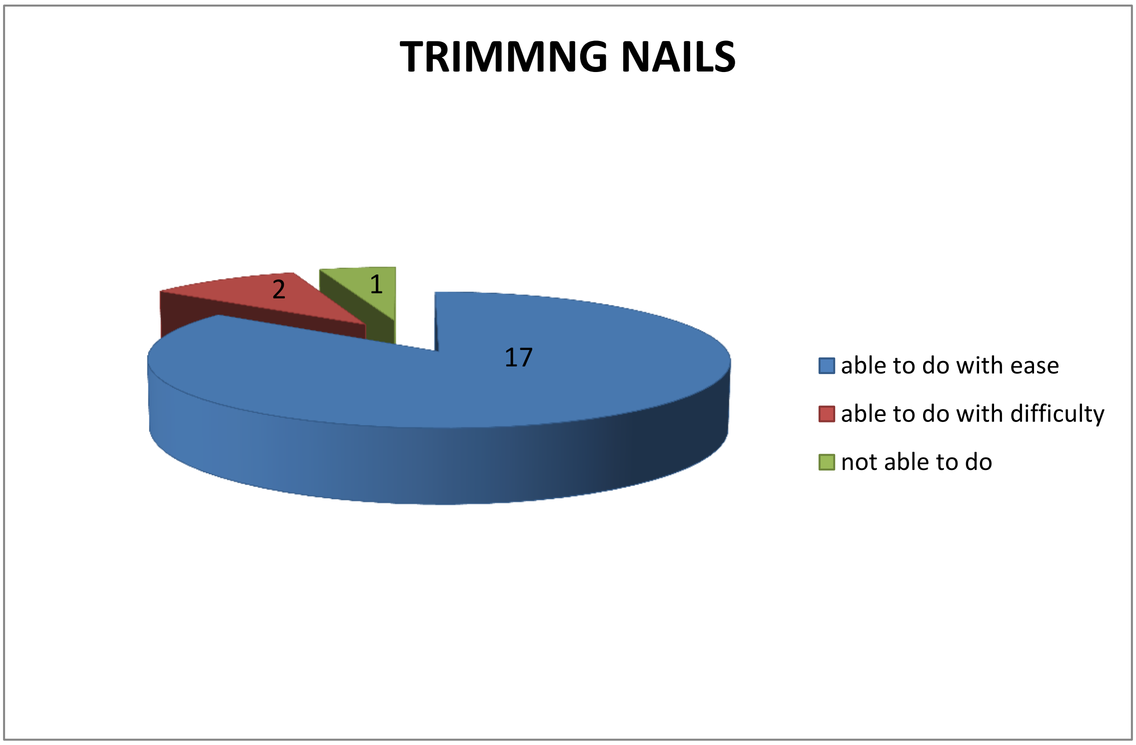
CLIMBING STAIRS

On evaluation of the patients ability to climb stairs, it was found that 15 patients (75%) were able to climb stairs without the use of any support or railing while the remaining 3 patients (15%) were able to do so with the support of the railing, 2 patients (10%) not able to climb



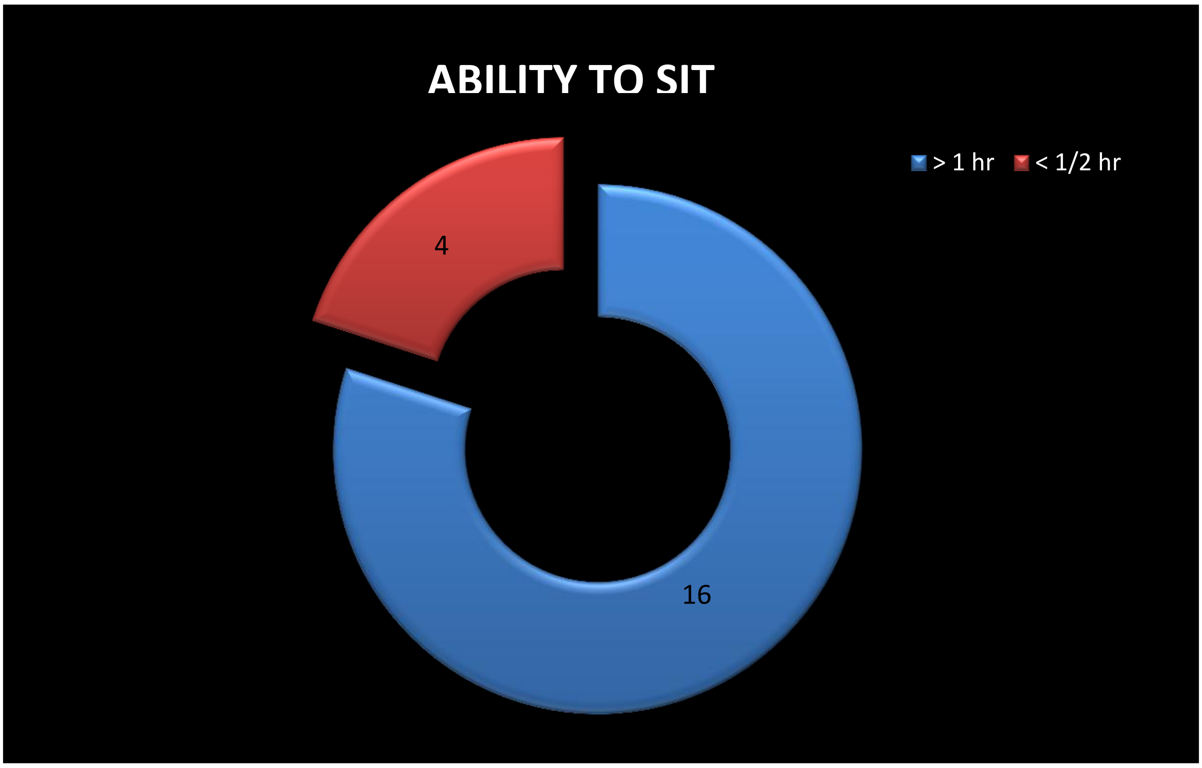
ABILITY TO TRIM NAILS

Our patients did not have the habit of using shoes and socks, their ability to trim their toe nails was used as a parameter for evaluation. It was found that 17 patients (85%) were able to trim their toe nails without any difficulty while 2 patients (10%) found it difficult to do so, 1 patient (5%) not able to do.



ABILITY TO SIT ON CHAIR FOR LONG DURATION

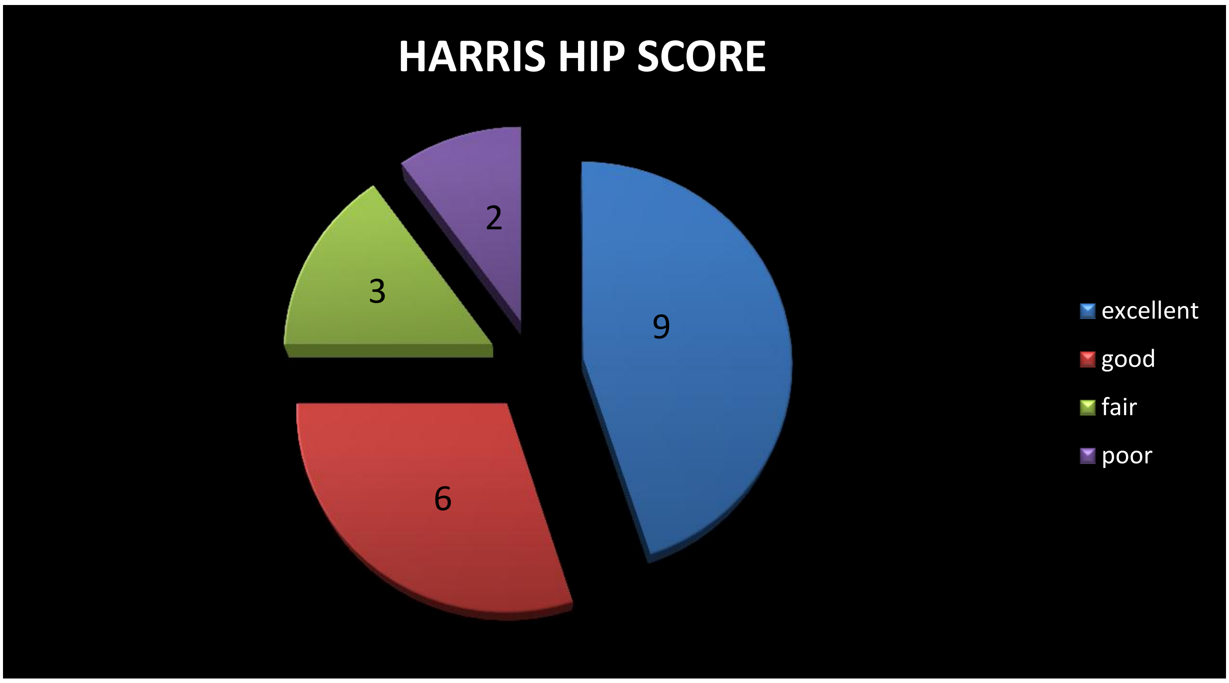
With regards to the ability to sit for a long duration it was found that 16 (80%) of the study patients were able to sit comfortably on a chair for upto one hour while 4 patients (20%) were not able to sit on a chair for more than half an hour at a stretch.



RESULTS

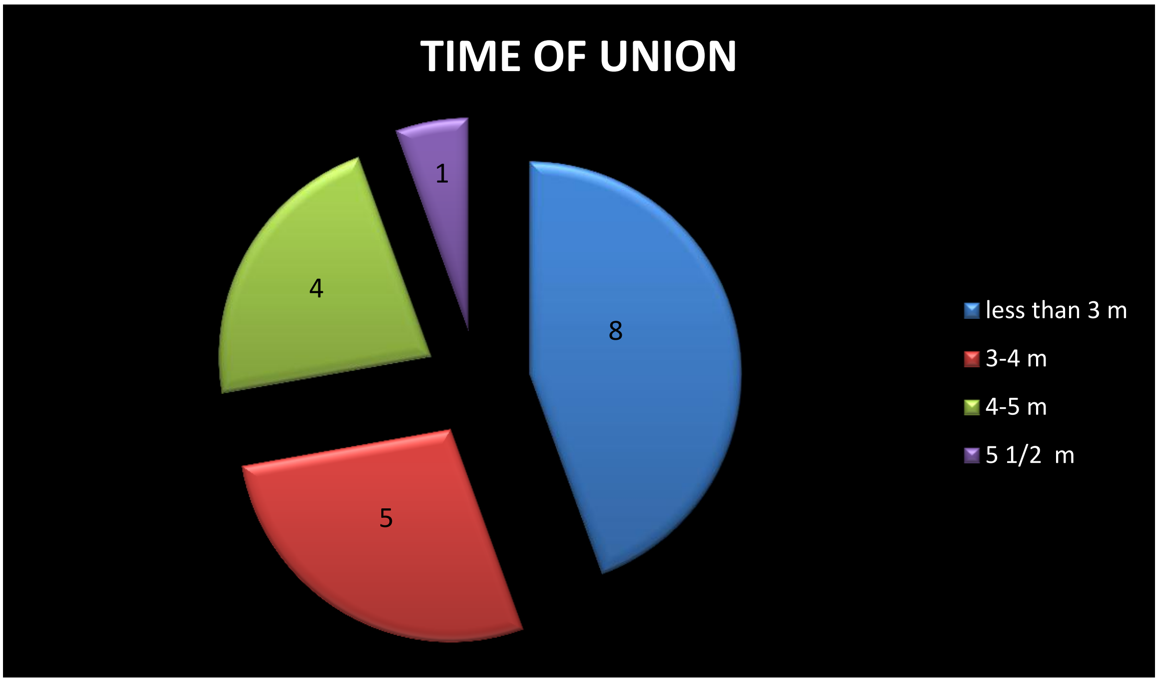
Harris Hip Score evaluated at maximum follow-up of our patients averaged 90.13 with the maximum score being 96 and the minimum score being 67.8. Overall, 9 patients (45%) achieved excellent result, 6 patients (30%) achieved good result, 3 patients (15%) achieved fair result and 2 patients (10%) achieved poor result. 75% of the patients achieved either excellent or good result.

GRADE	HHS	NO. OF PATIENTS	PERCENTAGE
Excellent	90-100	9	45
Good	80-89	6	30
Fair	70-79	3	15
Poor	<70	2	10



RADIOLOGICAL ANALYSIS:

On analyzing the anteroposterior view x ray of pelvis with hip in 15 degrees of internal rotation the radiological parameters such as fracture union, non-union changes, avascular necrosis in head, arthritic changes in the joint were analysed. Fracture union was seen in 18 patients and non union in 2 patients. The average time of union was less than 3 months in 8 patients (44.4%), 3 to 4 months in 5 patients (27.7%), 4 to 5 months in 4 patients (22.2%) and in 1 patient (5.55%) union achieved at 5 ½ months



The position of the screws and the fracture site alignment were assessed by comparing the final follow up x-ray with immediate post op x-ray to decide about the fixation failure using following criteria:

1. more than 10 mm displacement,
2. progression to varus angulation,
3. more than 5% change between the axis of the screws,
4. more than 20 mm of posterior translation, and
5. femoral head perforation.

Based on this criteria, we had 2 cases of fixation failure which later on resulted in non union.

COMPLICATIONS

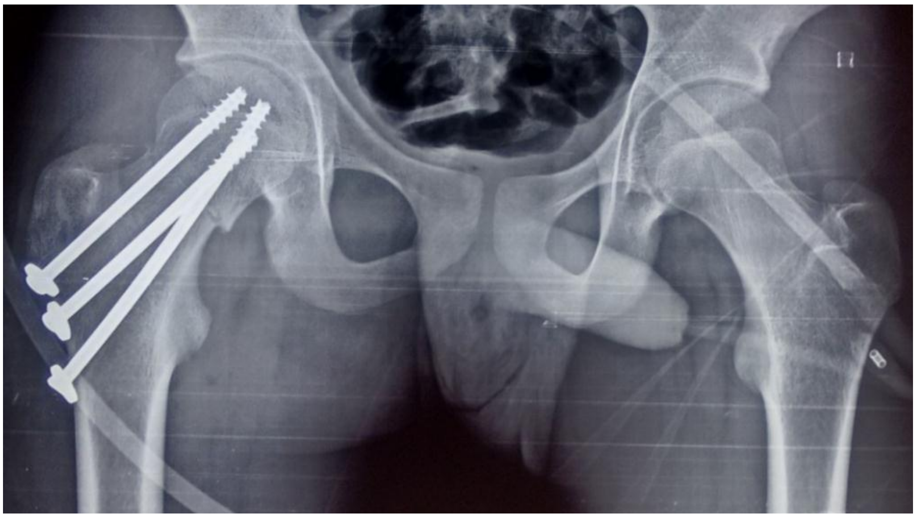
In our study we had 2 cases of superficial wound infection, 2 cases of screw pull out which fall under minor complications.

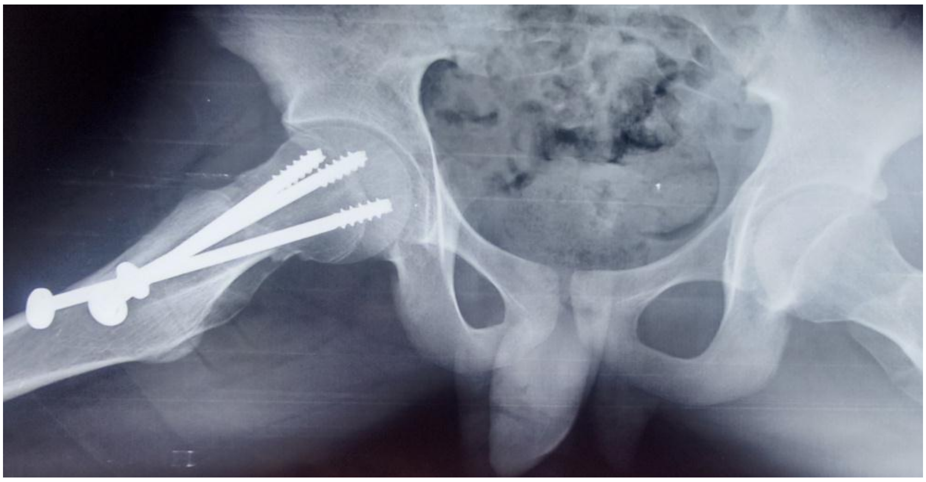
Major complications like non union of fracture were reported in 2 cases with poor functional outcome and 1 case of varus malunion .

CASE ILLUSTRATIONS

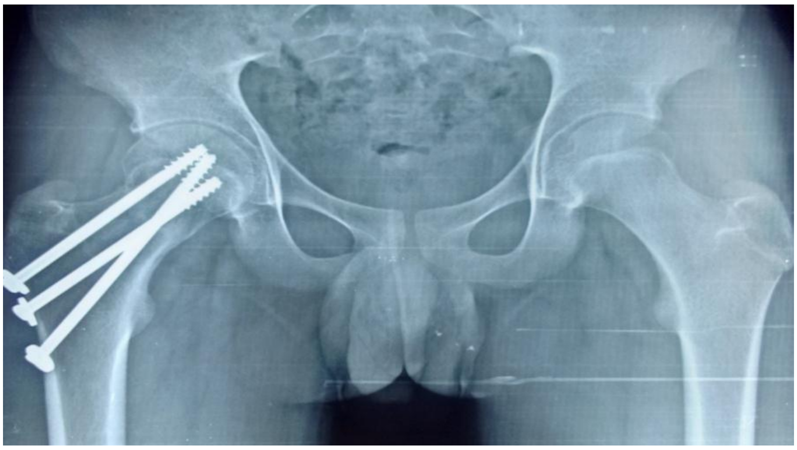
CASE 1 18 /M, GARDEN TYPE 3, PAUWEL TYPE 3

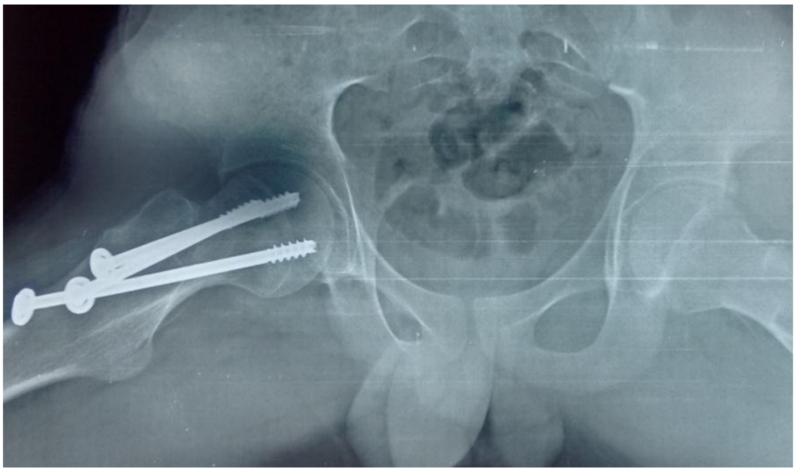
IMMEDIATE POST OP





FINAL FOLLOW UP (24 MONTHS)

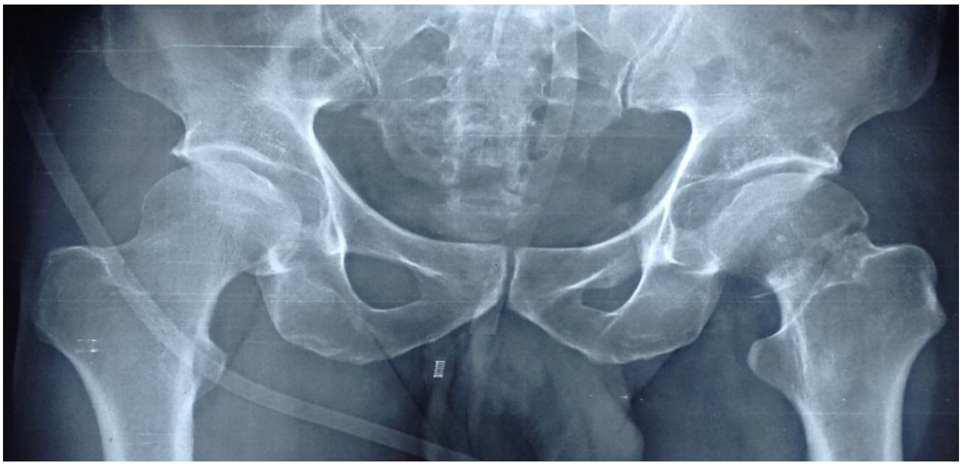




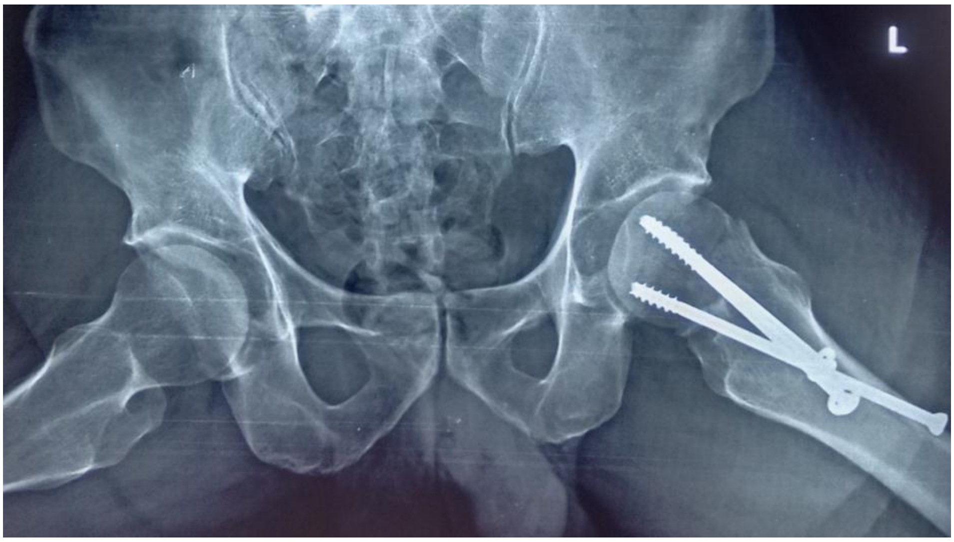
FUNCTIONAL OUTCOME- EXCELLENT

CASE 2

53/M, GARDEN TYPE 3, PAUWEL TYPE 2



IMMEDIATE POST OP

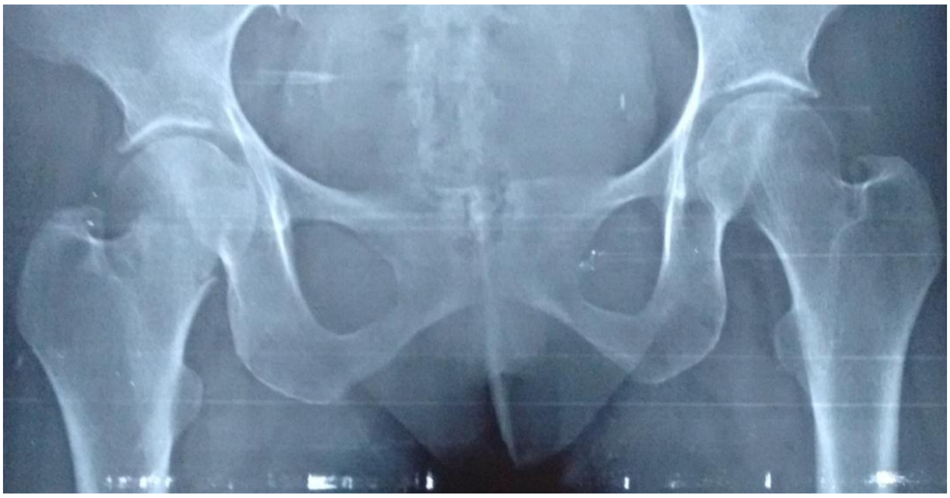


FINAL FOLLOW UP (19 MONTHS)

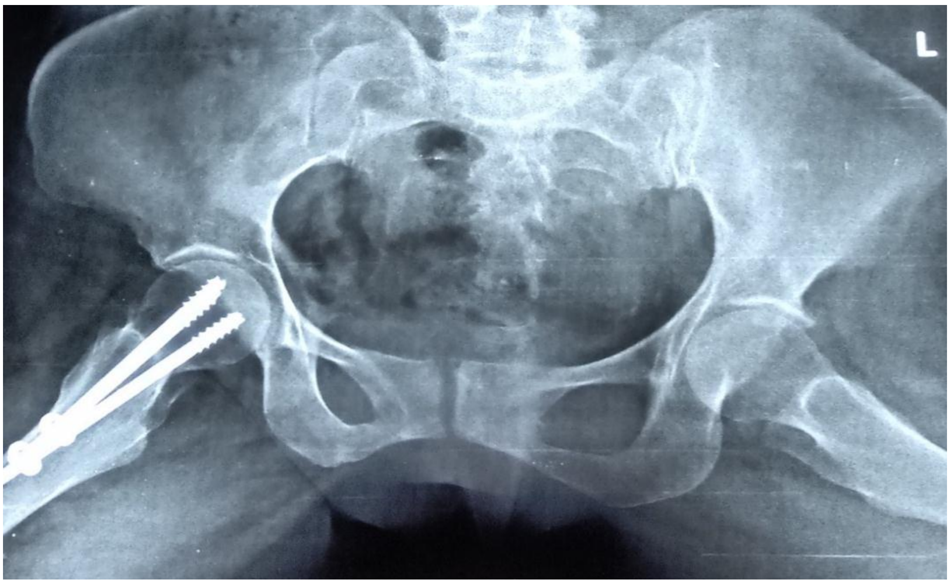
FUNCTIONAL OUTCOME- GOOD

CASE 3

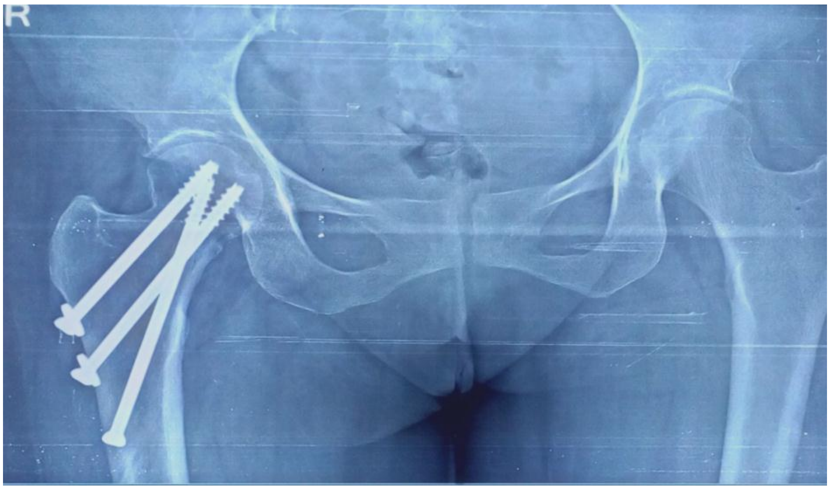
57/F, GARDEN TYPE 3, PAUWEL TYPE 2

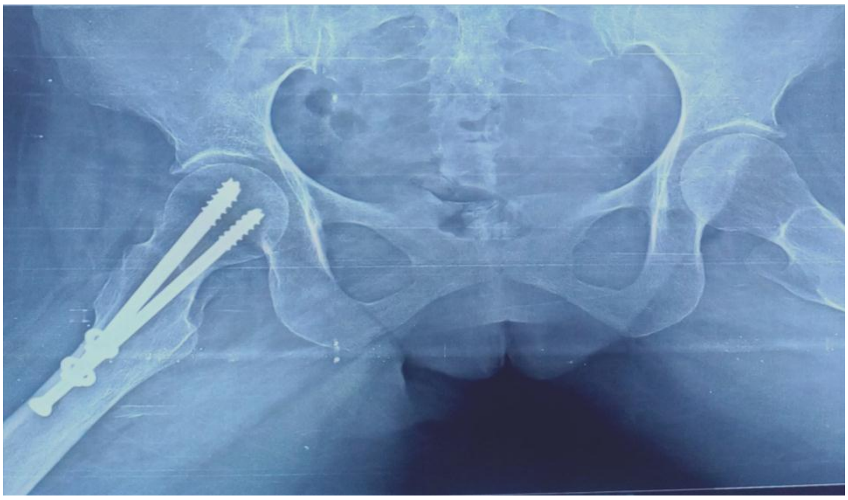


IMMEDIATE POST OP



FINAL FOLLOW UP (24 MONTHS)



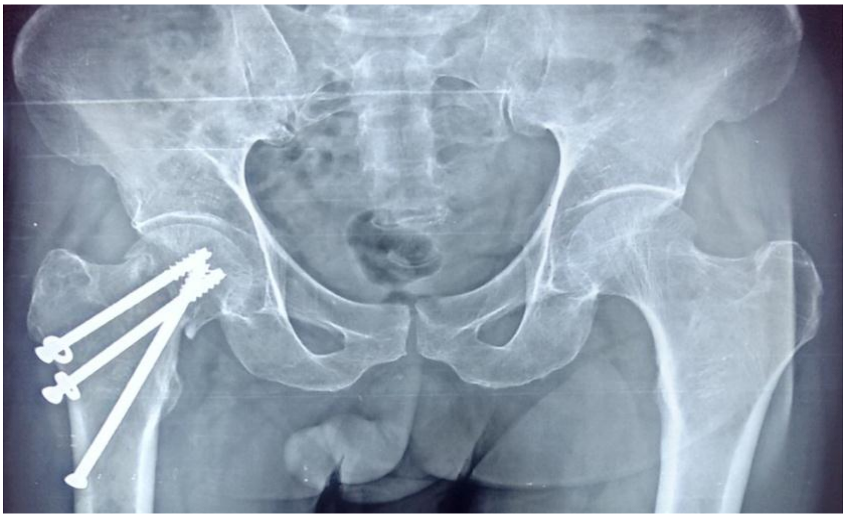


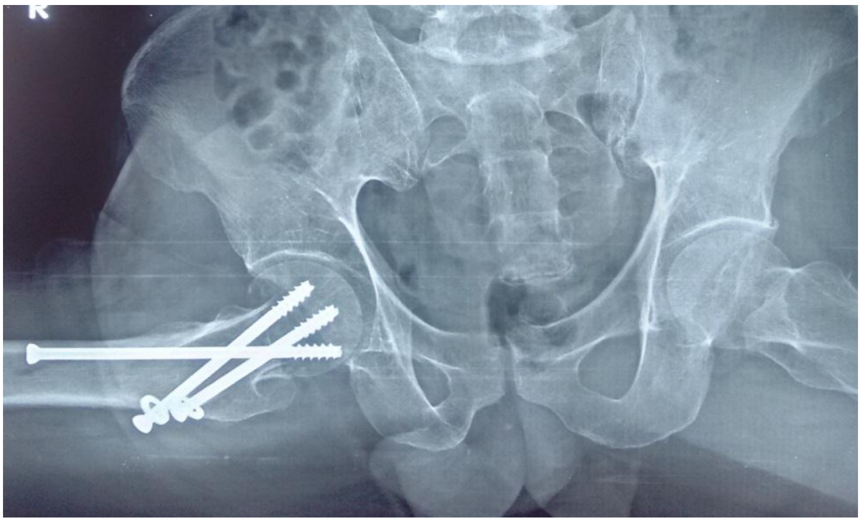
FUNCTIONAL OUTCOME- EXCELLENT

CASE 4

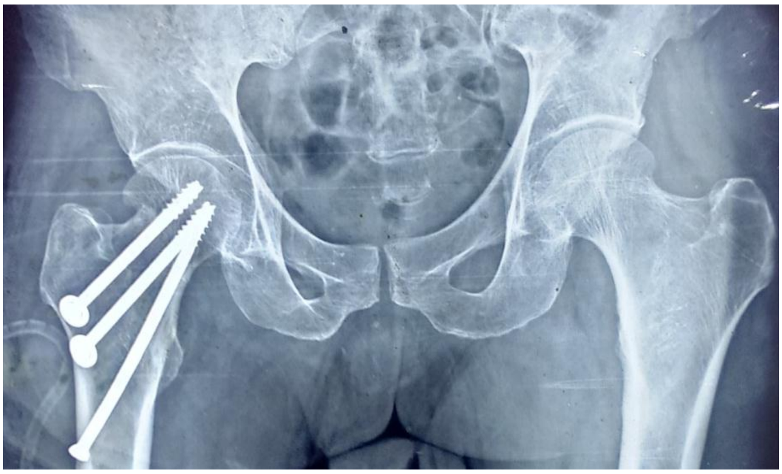
65/M, GARDEN TYPE 4, PAUWEL TYPE 3

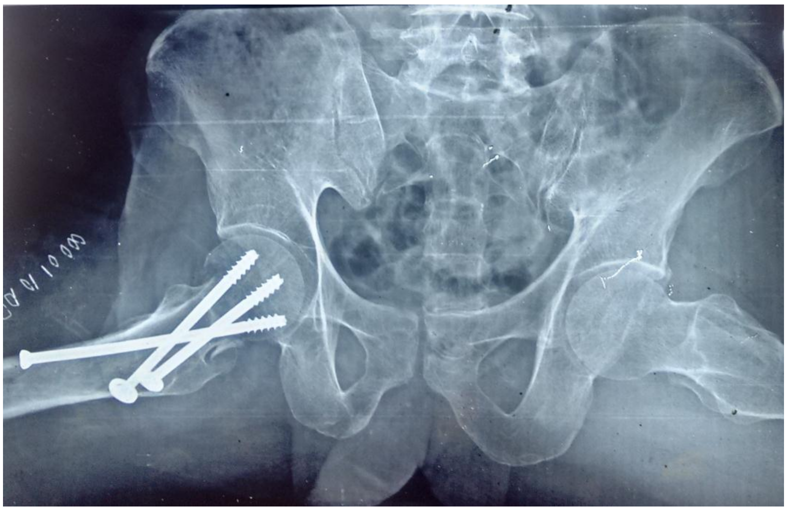
IMMEDIATE POST OP





FINAL FOLLOW UP (20 MONTHS)

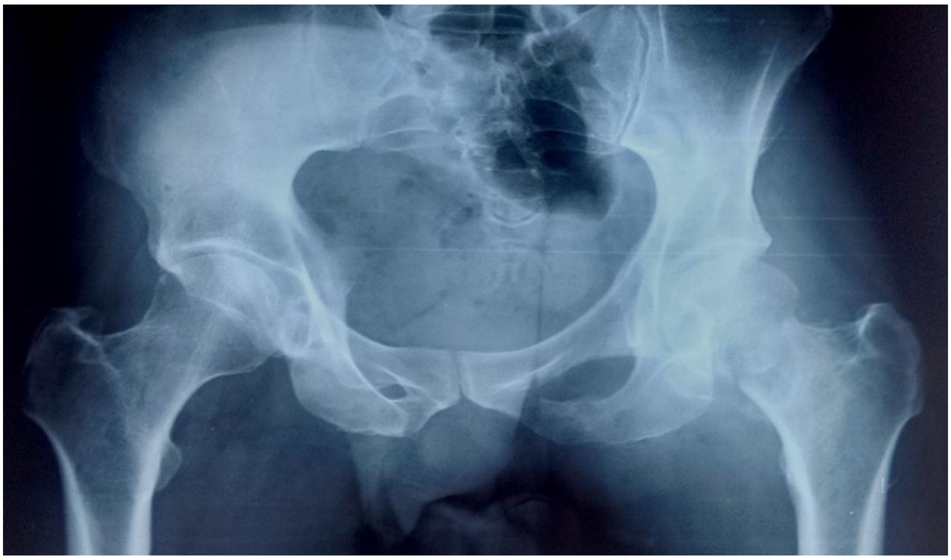




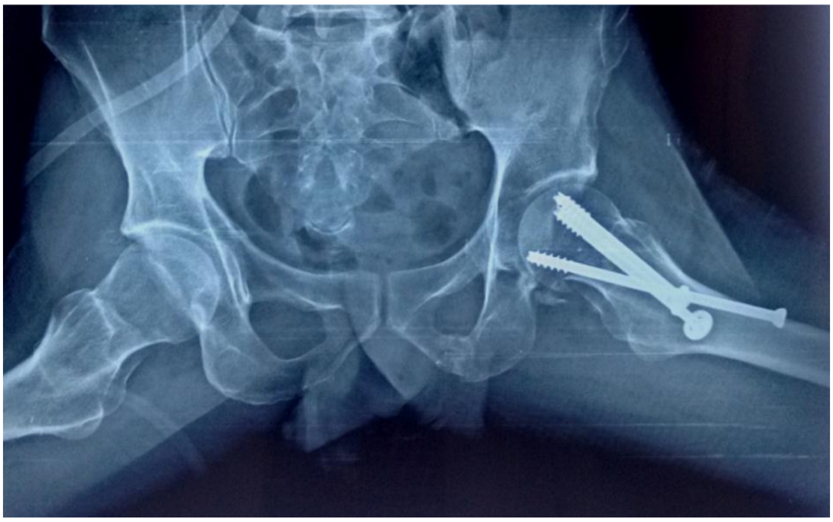
FUNCTIONAL OUTCOME- EXCELLENT

CASE 5

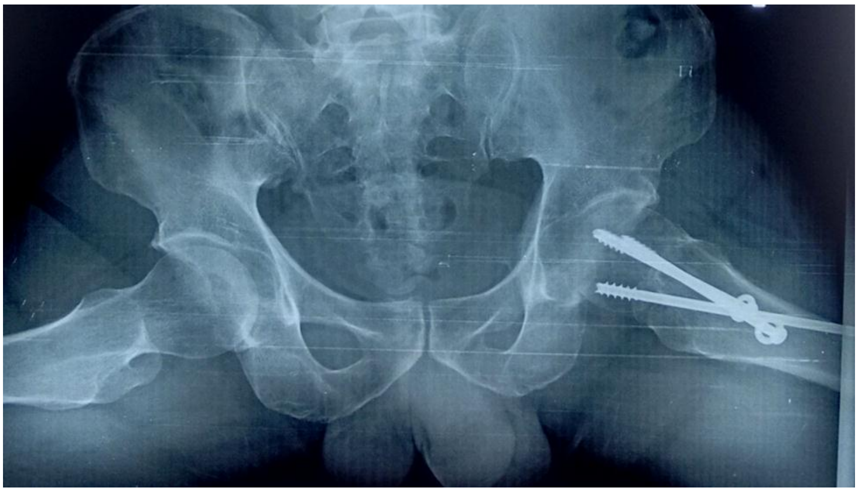
58/F, GARDEN TYPE 3, PAUWEL TYPE 2



IMMEDIATE POST OP



FINAL FOLLOW UP (17 MONTHS)



FUNCTIONAL OUTCOME- GOOD

CASE 6: A CASE OF NON UNION

54/F, GARDEN TYPE 4, PAUWEL TYPE 3

FOLLOW UP X – RAY

As the patient had complaint to pain and inability to bear weight, diagnosis of non union was made on regular follow up. Hence hemiarthroplasty was planned in this patient after implant removal.

DISCUSSION

Our study is focused on the clinical and radiological outcomes in neck of femur fracture fixation using the biplane double-supported screw fixation method described by Orlin Filipov which states that in respect of the fixation strength, the most original and effective is the distal screw—placed at obtuse angle and supported on a large area along the distal and posterior cortex of the femoral neck. Also, the two calcar - buttressed screws have their medial cortical supporting points located apart from each other, spreading the weight-bearing load over approximately 50% of the femoral neck cortex length without concentrating stress in a single spot.

Further Orlin Filipov and Boyko Gueorguiev did a biomechanical cadaveric study in 8 fresh frozen and 6 embalmed human femoral pairs in 2014 and proved that BDSF method of fixation is biomechanically stable fixation than conventional method of fixation [4]. This study on this method was undertaken to share our experience on BDSF method of fixation

The period defined in the literature for occurrence of bone union after osteosynthesis of femoral neck fractures is usually within 3 months post operation, and all complications related to mechanical and/or biological deficiencies, called with the collective term non -union, occur within 6 months, including failure of fixation and pseudoarthrosis.Therefore, we assumed a minimal follow-up period of 12 months as sufficient to demonstrate occurrence of bone union and other associated complications[1].

It is reported that the quality of reduction is the single most important factor within the surgeon's control influencing the rate of healing /complications [25, 26]. Besides the quality of reduction, a biomechanical stable fixation like BDSF method can prevent or reduce the failure rate.

We understood that the placement of guide wire for the distal screw at steeper angle of 150-160 degree was a tedious task, which can be mastered over time and experience.

In our study, we analysed the following parameters especially: age, fracture type according to Garden and Pauwel, time of presentation, timing of surgery and degree of posterior wall comminution with functional outcome of the patient.

In a study by Karl Stoffel et al., in addition to evaluation of clinical results by HHS, important parameters namely: age, gender, relief of pain (good, poor), mobility (good, poor) and putting on socks and shoes skills (easy, difficult) , degree of fracture displacement, incidence of AVN were analysed. He concluded that among all 207 patients, the Harris hip score was 86.2 ± 18.9 (range 10–100), with no significant difference between genders. This score was significantly higher for patients with Garden III versus Garden IV fractures. Also Harris hip score was significantly lower, for patients with poor versus good relief of pain, as well as in cases with poor versus good mobility and for patients declaring difficult versus easy putting on socks and shoes skills. [4]

In Karl Stoffel et al study, Harris hip score for patients aged below 65 years was similar to the age group 66–70 years, but significantly higher than in all other age groups.[1]

In our study we found that patient in younger age group preferably below 60 yrs had good functional outcome compared to patients above 60 years. With regarding to time of presentation and functional outcome, 10 patients who presented within 24 hrs of injury and operated earlier had good functional outcome with average Harris hip score of 89.5

Our study shows that patients with Pauwels type 3 (22.72%), and garden type 4 (36%) had low Harris hip score in comparison to other types. Moreover among 3 patients (15%) with posterior wall comminution , 2 patient had good functional outcome , while 1 patient had poor functional outcome.

Karl Stoffel et al., highlighted that 88.4% were pain free, 83.6% had good mobility, 80.7% of patient were able to put shoes and socks with ease.[4]

In our study out of 20 patients, 85% were pain free, 80% had good mobility, 85% of patients were able to trim nails with ease.

Two cases of fixation failure were reported in our study, where we found malposition of the screws in one of them and a significant lack of posterior cortical support in the second one which later on resulted in non union and poor functional outcome.

Incidence of non-union in operated patients in Orlin Filipov study was 6 out of 83 patients (7.2%) [2]

In our study the incidence of non union was 2 out of 20 cases (10%).

The rate of AVN seems to be similar worldwide and is slightly influenced by the applied fixation method and type of fracture pattern, rating about 9% (range 6–19%) for undisplaced and about 16% (range 9–32%) for displaced fractures [4].. Orlin filipov stated that the incidence of AVN in their study using this BDSF method is less (12.07%) when compared to conventional method of fixation (10-45%) quoted in the literature[1]. In our follow up period of 2 yrs there were no AVN in our patients.

The possibility of iatrogenic subtrochanteric fracture because of precarious placement of the distal most screw has not been reported in the previous studies. This may be explained as the wide distance between screws in BDSF (20–40 mm) might not weaken the subtrochanteric femur bone, because the tensile forces acting on the lateral cortex are spread over a larger area[1].

All the patients with the time of union of 3 months achieved excellent functional outcome. Other patients with longer union time achieved either good or fair functional outcome.

CONCLUSION

- BDSF method used in femoral neck fracture fixation has given very good results in our study.
- Difficulty in achieving distal screw fixation can be overcome by experience.
- Though anatomical reduction is crucial ,BDSF-method ensures reliable fixation, early rehabilitation and good functional outcome especially in elderly

BIBLIOGRAPHY

1. Filipov O (2011) Biplane double-supported screw fixation (F-technique): a method of screw fixation at osteoporotic fractures of the femoral neck. Eur J Orthop Surg Traumatol 21(7):539–543.
2. Filipov O (2013) The method of biplane double-supported screw fixation (BDSF) at femoral neck fractures—principle and clinical outcomes. J of IMAB 19(1):423–428
3. Filipov O, Gueorguiev B (2015) Unique stability of femoral neck fractures treated with the novel biplane double-supported screw fixation method: a biomechanical cadaver study. Injury 46(2):218–226 S.E. Asnis, L. Wanek-Sgaglione (1994) Intracapsular fractures of the femoral neck. Results of cannulated screw fixation. J Bone Joint Surg. 76, Vol.12, pp. 1793-1803
4. Femoral neck fracture osteosynthesis by the biplane double supported screw fixation method (BDSF) reduces the risk of fixation failure: clinical outcomes in 207 patients Orlin Filipov1 · Karl Stoffel2 · Boyko Gueorguiev3 · Christoph Sommer4: Arch Orthop Trauma Surg DOI 10.1007/s00402-017-2689-8
5. Walker E, Mukherjee DP, Ogden AL, Sadasivan KK, Albright JA (2007) A biomechanical study of simulated femoral neck fracture fixation by cannulated screws: effects of placement angle and number of screws. Am J Orthop 36(12):680–684

6. LaVelle DG (2008) Fractures and dislocations of the hip. In: Canale ST, Beaty JH (eds) Campbell's operative orthopaedics, 11th edn. Mosby Elsevier, Pennsylvania, pp 3237–3308
7. Tidermark J, Ponzer S, Svensson O, Söderqvist A, Törnkvist H (2003) Internal fixation compared with total hip replacement for displaced femoral neck fractures in the elderly. A randomised, controlled trial. J Bone Joint Surg Br 85(3):380–388 23.
8. Garden RS (1961) Low-angle fixation in fractures of the femoral neck. J Bone Joint Surg Br 43-B(4):647–663 24. Asnis SE, Wanek-Sgaglione L (1994) Intracapsular fractures of the femoral neck. Results of cannulated screw fixation. J Bone Joint Surg Am 76(12):1793–1803
9. Haidukewych GJ, Rothwell WS, Jacofsky DJ, Torchia ME, Berry DJ (2004) Operative treatment of femoral neck fractures in patients between the ages of fifteen and fifty years. J Bone Joint Surg Am 86-A(8):1711–1716 [9] Upadhyay A, Jain P, Mishra P, Maini L, Gautum VK, Dhaon BK (2004) Delayed internal fixation of fractures of the neck of the femur in young adults. A prospective, randomised study comparing closed and open reduction. J Bone Joint Surg Br 86(7):1035–1040
10. S. Lindequist (1993) Cortical screw support in femoral neck fractures. A radiographic analysis of 87 fractures with a new mensuration teqhnique. Acta Orthop.64, Vol.3, pp. 289-293

11. R.S. Garden (1961) Low-angle fixation in fractures of the femoral neck. J Bone Joint Surg. Br 43-B, Vol.4, pp. 647-663

12. L. Hernefalk, K. Messner (1996) Rigid osteosynthesis decreases the late complication rate after femoral neck fracture. Archives of Orthopaedic and Trauma Surgery, 115, pp. 71-74

13. V. Selvan, M. Oakley, A. Rangan, M. A-Lami (2004) Optimum configuration of cannulated hip screws for the fixation of intracapsular hip fractures: a biomechanical study. Injury 35, Vol.2, pp. 136-141

14. Walker, D. Mukherjee, A. Ogden, K. Sadasivan, J. Albright (2007) A biomechanical study of simulated femoral neck fracture fixation by cannulated screws: effects of placement angle and number of screws. Am J Orthop. 36, Vol.12, pp. 680-684

15. J. Dickson (1953) The "unsolved" fracture: a protest against defeatism. J Bone Joint Surg. Am 35, pp. 805-822

16. O. Filipov (2011) Biplane double-supported screw fixation (F-technique): a method of screw fixation at osteoporotic fractures of the femoral neck. Eur J Orthop. Surg. Traumatol 21, pp. 539-543

17. W.H. Harris (1969) Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg. 51A, pp. 735-755

18. Liporace, R. Gaines, C. Collinge, G. Haidukewych (2008) Results of internal fixation of Pauwels type-3 vertical femoral neck fractures. J Bone Joint Surg. Am 90, pp. 1654-9

19. Tidermark J, Ponzer S, Svensson O, Söderqvist A, Törnkvist H (2003) Internal fixation compared with total hip replacement for displaced femoral neck fractures in the elderly. J Bone Joint Surg. Br 85-B(3): 380-388

20. Paus A, Gjengedal E, Hareide A, Jorgensen JJ. Dislocated fractures of the femoral neck treated with von Bahr screws or hip compression screw: results of a prospective, randomized study. J Oslo City Hosp. 1986 MayJun;36(5-6):55-61.

21. Rehnberg L, Olerud C. The stability of cervical hip fractures and its influence on healing. J Bone Joint Surg Br. 1989 Mar; 71-B(2):173-177.

22. Lindequist S. Cortical screw support in femoral neck fractures. A radiographic analysis of 87 fractures with a new mensuration teqhnique. Acta Orthop Scand. 1993 Jun;64(3):289-293.

23. Parker MJ, Tagg CE. Internal fixation of intracapsular fractures. J R Coll Surg Edinb. 2002 Jun;47(3):541547.

24. Lykke N, Lerud PJ, Stromsoe K, Thorngren KG. Fixation of fractures of the femoral neck: a prospective, randomised trial of three Ullevaal hip screws versus two Hansson hook-pins. J Bone Joint Surg Br. 2003 Apr;85(3): 426-430.

25. Booth KC, Donaldson TK, Dai QG. Femoral neck fracture fixation: a biomechanical study of two cannulated screw placement techniques. Orthopedics. 1998 Nov;21(11):11731176.

26. Lagerby M, Asplund S, Ringqvist I. Cannulated screws for fixation of femoral neck fractures: no difference between Uppsala and Richards screws in a randomized prospective study of 268 cases. Acta Orthop Scand. 1998 Aug;69(4):387-91.

27. Madsen F, Linde F, Andersen E, Birke H, Hvass I, Poulsen TD. Fixation of displaced femoral neck fractures: a comparison between sliding screw plate and four cancellous bone screws. Acta Orthop Scand. 1987 Jun;58(3):212-16.

28. Elmerson S, Andersson GB, Irstam L, Zetterberg C. Internal fixation of femoral neck fracture: no difference between the Rydell four-flanged nail and Gouffon's pins. Acta Orthop Scand. 1988 Aug;59(4):372-6.

29. Gurusamy K, Parker MJ, Rowlands TK. The complications of displaced intracapsular fractures of the hip: the effect of screw positioning and angulation on fracture healing. J Bone Joint Surg Br. 2005 May;87(5):632-634.

30. Mizrahi J, Hurlin RS, Taylor JK, Solomon L. Investigation of load transfer and optimum pin configuration in the internal fixation, by Muller screws, of fractured femoral necks. Med Biol Eng Comput. 1980 May;18(3):319325. 27. Swiontkowski MF, Harrington RM, Keller TS,

Van Patten PK. (1987) Torsion and bending analysis of internal fixation techniques for femoral neck fractures: the role of implant design and bone density. J Orthop Res. 1987; 5(3):433-444.

31. Lykke N, Lerud PJ, Stromsoe K, Thorngren KG (2003) Fixation of fractures of the femoral neck. A prospective, randomised trial of three Ullevaal hip screws versus two Hansson hook-pins. J Bone Joint Surg Br 85(3):426–430

32. Harris WH (1969) Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 51(4):737–755 [33] Banks HH (1962) Factors influencing the result in fractures of the femoral neck. J Bone Joint Surg Am 44(5):931–9

PATIENT CONSENT FORM

Study detail:

"Functional outcome of neck of femur fracture treated by biplane double supported screw fixation"

Study centre : GOVT ROYAPETTAH HOSPITAL, CHENNAI

Patients Name :

Patients Age :

Identification Number :

Patient may check (✓) these boxes

I confirm that I have understood the purpose of procedure for the above study. I had the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

I hereby make known that I have fully understood the use of above surgical procedure, the possible complications arising out of its use and the same was clearly explained to me and also understand that this technique is a new method of treatment of patella fractures and this study is done to know the usefulness of the same in management of patella fractures

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms. ☐

I hereby consent to participate in this study.

I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, radiological tests. ☐

Signature/thumb impression:

Patients Name and Address: place date

Signature of investigator :

Study investigator's Name : place date

நோயாளி ஒப்புதல் படிவம்

ஆராய்ச்சியின் விவரம் :

ஆராய்ச்சி மையம் :

நோயாளியின் பெயர் : நோயாளியின் வயது :

பதிவு எண் :

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✔) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐

2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாரய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐

4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ எற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐

5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐

6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை

ஆராய்ச்சியாளரின் கையொப்பம்

இடம்: தேதி:

PROFORMA

Patient's Name :

Age:

Sex:

Occupation:

Address:

Contact no:

Date of Injury:

Mode of Injury:

Date of admission:

I.P.No:

Diagnosis:

Treatment given on admission:

Investigations : Complete haemogram ,

Blood urea,sugar,Sr.Creatinine

Bleeding time and clotting time

ECG

Chest X-ray

Plain X-ray AP and Lateral view of the affected limb

Associated illness :

Plan:

Date of surgery:

Time delay for surgery:

Procedure done:

Implants used:

Intra operative complications if any:

Post operative complications:

Immediate:

Delayed:

Late:

Post operative mobilisation started at:

Post operative weight bearing started at:

Partial:

Full:

Follow up:

Evaluated with AP view of pelvis – radiological assessment and harris hip score, c- arm examination

Immediate post op

4 weeks post op

8 weeks post op

3 months post op

6 months post op

HARRIS HIP SCORE

Pain

- None or ignores it (44)
- Slight, occasional, no compromise in activities (40)
- Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
- Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than aspirin (20)
- Marked pain, serious limitation of activities (10)
- Totally disabled, crippled, pain in bed, bedridden (0)

Limp

- None (11)
- Slight (8)
- Moderate (5)

- Severe (0)

Support

- None (11)
- Cane for long walks (7)
- Cane most of time (5)
- One crutch (3)
- Two canes (2)
- Two crutches
- Not able to walk (0)

Distance Walked

- Unlimited (11)
- Six blocks (8)
- Two or three blocks (5)
- Indoors only (2)
- Bed and chair only (0)

Sitting

- Comfortably in ordinary chair for one hour (5)
- On a high chair for 30 minutes (3)
- Unable to sit comfortably in any chair (0)

Enter public transportation

○ Yes (1)

○ No (0)

Stairs

○ Normally without using a railing (4)

○ Normally using a railing (2)

○ In any manner (1)

○ Unable to do stairs (0)

Put on Shoes and Socks

○ With ease (4)

○ With difficulty (2)

○ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)

Less than 30° fixed flexion contracture	Yes	No
Less than 10° fixed abduction	Yes	No
Less than 10° fixed internal rotation in extension	Yes	No
Limb length discrepancy less than 3.2 cm	Yes	No

Range of Motion (*indicates normal)*

Flexion (*140°) ____________

Abduction (*40°) __________

Adduction (*40°) ___________

External Rotation (*40°) ___________

Internal Rotation (*40°) __________

Range of Motion Scale

211° - 300° (5)   61° - 100 (2)

161° - 210° (4)   31° - 60° (1)

101° - 160° (3)   0° - 30° (0)

Range of Motion Score ____________

Total Harris Hip Score ____________

At maximum period of follow up

FUNCTIONAL ASSESSMENT :

Radiological assessment:

Harris hip score:

Overall the patient has _______functional outcome

ETHICAL COMMITTEE APPROVAL

INSTITUTIONAL ETHICS COMMITTEE
GOVT. KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Protocol ID. No.06/2016 Meeting held on 14/12/2016
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval **"FUNCTIONAL AND RADIOLOGICAL OUTCOME OF NECK OF FEMUR FRACTURE TREATED BY BIPLANE DOUBLE SUPPORTED SCREW FIXATION METHOD"** submitted by Dr.R.Karthik., Post Graduate in M.S.(Ortho), Govt. Kilpauk Medical College, Chennai.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

6/1/17
DEAN
Govt. Kilpauk Medical College,
Chennai-10.

4/1/17

MASTER CHART

S .No.	Age/ sex	Mode of injury	Type of fracture	Pauwel & Garden type	Time of presentation	Timing of surgery	Follow up month	Time of union	Harris hip score	Functional out come	Complication
1	56/M	slip & fall	subcapital	PT-3 GT-4	8 hrs	2 days	17 m	3 ½ m	96	Excellent	nil
2	65/M	Slip & fall	transcevical	PT-3 GT-4	6 hrs	3 days	20 m	3 m	92	Excellent	nil
3	53/M	RTA	transcervical	PT-2 GT-3	9 hrs	4 days	8 m	4 m	89	Good	nil
4	59/M	RTA	transcervical	PT-2 GT-3	30 hrs	4 days	12 m	4 ½ m	84	Good	screw pullout
5	62/F	RTA	transcervical	PT-2 GT-4	2 hrs	3 days	15 m	4 ½ m	92	Excellent	nil
6	45/M	FFH	subcapital	PT-1 GT-4	2 days	3 days	7 m	3 m	90	Excellent	nil
7	18/M	RTA	transcervical	PT-3 GT-3	4 hrs	2 days	24 m	3 m	94	Excellent	nil
8	66/M	Slip & fall	basicervical	PT-1 GT-2	6 hrs	4 days	10 m	5 m	86	Good	screw pullout
9	34/M	RTA	transcervical	PT-2 GT-2	5 days	7 days	14 m	3 m	91	Excellent	nil
10	54/F	RTA	transcervical	PT-3 GT-4	10 days	15 days	9 m	_	68	Poor	Non-union
11	63/M	Slip& fall	subcapital	PT-1 GT-2	4 days	7 days	10 m	3 m	93	Excellent	Nil
12	51/M	RTA	subcapital	PT-2 GT-3	2 day	4 days	13 m	3 m	83	Good	Nil

13	71/M	RTA	transcervical	PT-2 GT-2	5 hrs	3 days	15 m	_	66	Poor	Non-union
14	72/M	FFH	subcapital	PT-1 GT-3	28 hrs	4 days	10 m	4 1/2 m	86	Good	Wound Infection
15	54/F	Slip& fall	transcervical	PT-2 GT-3	4 hrs	3 days	16 m	4 m	78	Fair	Nil
16	66/M	RTA	subcapital	PT-1 GT-1	30 hrs	5 days	12 m	5 ½ m	76	Fair	Varus Malunion
17	57/F	RTA	transcervical	PT-2 GT-3	5 days	8 days	24 m	3 m	97	Excellent	Nil
18	59/F	RTA	trascervical	PT-1 GT-3	6 days	9 days	18 m	3 m	95	Excellent	Nil
19	55/F	Slip & fall	subcapital	PT-1 GT-3	7 days	10 days	7 m	5 m	79	Fair	Distal screw Penetration
20	58/F	RTA	transcervical	PT-2 GT-3	26 hrs	5 days	17 m	4 m	86	Good	Wound Infection

RTA- road traffic accidents, PT- pauwel type, GT-garden type